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INTRODUCTION TO THE SECOND VOLUME.

By SIR ROBERT MOND, LL.D., M.A., F.R.S.

THE Society for the Study of Alchemy and Early Chemistry is entering on the second year of its existence. It has succeeded in publishing three numbers of its Journal, *Ambix*. All those who have had an opportunity of perusing them must have been struck by the large field of research which awaits our investigators. Their importance to the proper understanding of the history of our ideas, the discovery of the facts on which they are based, and the evolution of these ideas in proportion to the augmentation of our knowledge of these facts, fully justify our efforts.

Spinoza, in his *Treatise on the Improvement of the Understanding*, pointed out the importance of simple ideas as tools for the fashioning of more complex ideas, and our studies elucidating the cogitation of our predecessors, on what we now recognize as chemical phenomena, demonstrate the process by which, from a large number of discrete and apparently irreconcilable observations, some simple deductions could be arrived at, which in their turn became the starting-points for the nearly innumerable products which are now at our command,

As in all examples of human endeavour we realize in all ages the immense debt we owe to a very small number of those to whom real progress is due. Hence all our endeavours are limited to the study of the works of those who have succeeded in making posterity associate their names with their achievements. This is not surprising, considering how in all other fields of human endeavour, such as Religion, Philosophy, Politics, etc., the same phenomenon is observed.

Such individuals, few in a generation, but still to be found, if searched for diligently, await our recognition and our assistance. And our study of these heroes of the past should facilitate our task in the present and the future.

Many of the chief problems which agitated the minds of our ancestors, such as the Elixir Vitæ and the Philosopher's stone, are finding partial solution in our rapidly increasing knowledge of the hormones and the transmutation of atoms by bombardment with protons and neutrons.

We are beginning to be able to eliminate the accidental and capricious nature of the observed phenomena (and which of us is not painfully aware of the scantiness of our knowledge?). But it is just this difficulty we experience in expanding our own knowledge which emphasizes the utility of studying the difficulties our predecessors encountered and vanquished.

In many directions we are yet where they started, and hence their struggles are of the most living interest and of the greatest value.

The fact that we as human beings are ourselves chemical works, owing our existence to a correlated system of chemical reactions, makes it not surprising that early knowledge was to a large extent based on pharmaceutical preparations, and it was owing to the complexity of the ingredients employed that progress in the recognition of the properties of the various constituents was much retarded, as witness early Indian Chemistry.

It is only when we consider how recently Lavoisier laid bare the phenomenon of oxidation, that the synthesis of urea by Wöhler, making the first break in the doctrine of vital chemistry, has just passed its centenary, and that our modern conceptions of matter have scarcely yet come of age, that we begin to understand the task undertaken by our predecessors, the burden they had to bear, and to render our appreciation and gratitude to their endeavours, by studying with reverence and sympathy the path they had to pursue, which has enabled us to benefit by their experience.

We know that we are starting on right lines, that our work will have lasting usefulness, and that it will provide pleasure and satisfaction both to the authors and the readers of *Ambix*. Let us proceed with confidence into the future.

A SURVEY OF THE CHEMISTRY OF ASSYRIA IN THE SEVENTH CENTURY B.C.¹

By R. CAMPBELL THOMPSON, D.Litt., F.B.A., F.S.A.

THE following paper, while giving practically nothing new², is intended to present a short survey of the more important indications of the ancient Mesopotamian knowledge of chemistry.

The sources from which our knowledge of Assyrian Chemistry is obtained are a very small part of the collections of cuneiform tablets in our museums, which may perhaps be reckoned at a quarter of a million roughly in number, and of this chemistry almost all our knowledge comes from tablets of the Seventh Century B.C. But that the ancient Sumerians had a very practical knowledge of chemical methods even before the invention of writing, let us say, very early in the Fourth Millennium B.C., is to be inferred from the beautiful gold work found by Sir Leonard Woolley at Ur, and the copper and bronze castings found throughout Southern Mesopotamia. The written word, however, of their methods has survived only sparsely by comparison, this being due to three causes: first, the illiteracy of the craftsmen; secondly, the habit of all Guilds to conceal their methods by the use of cryptic expressions; and thirdly, the close guarding of secrets, which were frequently handed down from father to son by word of mouth.

Our actual formulæ may be said to exist first in tablets of the Third Millennium, when we are beginning to get references to substances which, for want of a better term, may be called chemicals.

In the Seventeenth Century B.C. we have a text of outstanding importance for the history of Chemistry in a tablet written by a glass-maker. Later on, in the Seventh Century, we have a collection of glass recipes made at the instance of King Ashurbanipal (668-626 B.C.). More generally we have a large collection of medical texts which allow us to identify numerous substances in use during the First Millennium B.C. Finally I must mention numerous Sumero-

¹ A paper read before the Society for the Study of Alchemy and Early Chemistry.

² Except the note on *ḥaṣḥallatu*, p. 6, and the equivalence 'wool of the dome' for *KÛ.ĤĒ*, pompholyx, *lana philosophica*, p. 8. I am greatly indebted to the Oxford University Press for large quotations from my book, *A Dictionary of Assyrian Chemistry and Geology*, 1936 (given herein as *DACG*). For those who are not Assyriologists I think it would be well to state that the Assyrians marked their minerals and plants with the determinatives *abnu* and *šammu* respectively.

Assyrian dictionaries which give lists of chemical words, also dating to the same period.

By 650 B.C. the list of chemicals may be said to include Common Salt, *Sal gemma*, red *Sal Gemma*, Lime, Saltpetre from the earth, Carbonate of Soda from the walls, Nitrate of Potash from walls, Sal Ammoniac, Alkali from plants, Gypsum, Mercury from cinnabar, Alum, Black and Yellow Sulphur, Bitumen, various forms of Arsenic, red and black Copper Oxide, Chrysocolla, Acetate of Copper, Spodos and Pompholyx (oxides of zinc), Iron Oxides, Hæmatite, Magnetic Iron Ore, Iron Pyrites (which leads to the Vitriols), Iron Sulphide, Copper Sulphate; and, if I am right, they had a word *ḥannabahru* for the fuming sulphuric acid from Green Vitriol.

Then there appears to have been a simple hardness scale of which the degrees are indicated by the postpositive addition of the signs *AŠ* and *AŠ.AŠ* to the softer blue and white stones, and, if I am right, the method used by modern mineralogists of testing sedimentary rocks with acid, as indicated by the word *ZA.TU*, 'acetated', placed in front of the words for green and white rocks, which must otherwise be taken, I presume, to be igneous.

One early formula, about the last quarter of the Third Millennium, for an alloy runs:

1 mana 4 shekels of *URUDU.LAḤ.ḤA* (refined copper),
 $10\frac{2}{3}$ shekels of *AN.NA* (tin),
 $4\frac{2}{3}$ shekels of *NE.KU*,
 $\frac{1}{2}$ shekel, 21 gr. of *SÛ.ḤÉ*.

From *DACG*, 77, it would appear that *SÛ.ḤÉ* ('that which falls in the dome') is the spodos, the heavier oxide of zinc, as contrasted with the *KÛ.ḤÉ*, 'the *KÛ* of the dome', pompholyx, the lighter oxide. The actual monetary value of *SÛ.ḤÉ* was from $1\frac{1}{2}$ to 2 shekels of silver the *mana* (the shekel weighing one-sixtieth of the *mana*) about this time (Reisner, *Tempelurkund.*, 30)³.

If we take the percentages of these components we get:

80.05 per cent. copper,
 13.34 per cent. tin,
 0.77 per cent. zinc oxide,
 5.84 per cent. *NE.KU*.

As will be obvious, the first three constitute a composition similar to brass or gun-metal, one form of the latter in modern times being 89.3 per cent. copper, 6.8 per cent. tin, 2.2 per cent. zinc, 1.2 per cent. iron. What, then, is the *NE.KU*?

³ Copper at this time was worth 1 shekel of silver for 2 to $2\frac{1}{3}$ *manas*, i. e., approximately a quarter of the value of *SÛ.ḤÉ* (*ib.*, 7).

It certainly cannot represent the iron of the more modern formula. Literally it means 'ash eaten', doubtless 'ash eaten by fire', in which case we shall have no difficulty in seeing 'charcoal' in it, a meaning proved by an early tablet which shows that it was used with 'good *NI.NUN*-ghee' (clarified butter) with wool, *i. e.*, as a soap⁴. Beech ash would appear to have been used in early soaps (*Encyc. Brit.*, 11th ed., s. v.). It is well known that in melting bronze or brass the addition of charcoal as a deoxidizing agent is of great value; *e. g.*, J. C. Booth, *Encyc. of Chemistry*, says that many founders cover their melted metal (*i. e.*, bronze) with fine charcoal or coke, and that is how we must translate *NE.KÛ* in our gun-metal formula.

Perhaps the most interesting text in all the cuneiform chemical tablets is the glass-maker's document of the Seventeenth Century B.C. which I have already mentioned, written in a beautiful hand, and in a perfect state of preservation. It is first, I think, a duty to record his name as that of the earliest glass-maker known, Liballit (?) -Marduk, the son of Uššur-an-Marduk, a priest of Marduk at Babylon.

This contains the earliest record of making glaze with copper and lead for pots, and for making a pot with a green body (the clay being mixed with verdigris). Not the least interesting point is that the writer has anticipated the cryptic jargon of the alchemists of a later period, whereby he hopes to conceal his knowledge from those not in his Guild. He has made a point of using the rarest cuneiform signs, and of giving the most recondite values to such well-known signs as he uses. His first two formulæ run:

- (1) 1 mana of *zuku* (plain glaze),
 10 shekels of lead,
 15 shekels of copper,
 $\frac{1}{2}$ (shekel) of saltpetre,
 $\frac{1}{2}$ (shekel) of lime.
- (2) 1 mana of *zuku* (plain glaze),
 10 (shekels) of lead,
 14 (shekels) of copper,
 2 shekels of lime,
 1 shekel of saltpetre.

(For Seventh-Century components of the *zuku* see below.)

He gives his pot a green 'body' by steeping the clay in copper and vinegar for three days, and in order to preserve the chemicals which compose

⁴ The text is in Pinches, *Amherst Tablets*, No. 50, iv, 7 ff., total 4 talents 2 *manas* of goats' hair (about 242 lbs.), total $\frac{1}{2}$ *ka* of good *NI.NUN* (ghee), *NE.KÛ.BI* (its charcoal, ash), $1\frac{1}{2}$ shekel (the *ka* is .84 litre, the shekel 8.41 grammes).

the glaze from damp he directs that they should be stored in an old wine-skin⁵.

The next glass-texts known, in sequence of time, are those which were copied for the Royal Library at Nineveh (and also for the Temple of Nabû there) at the instance of Ashurbanipal. Much of the original five tablets, which contained more than twenty recipes for glazes, has survived and is now in the Kouyunjik Collection in the British Museum.

They begin with detailed directions how to make the furnace, demanding ceremonial purity of the men during the work, and requiring the introduction into the actual building of embryos, almost certainly human, which, as incomplete products, are to be placated from time to time by offerings, so that by sympathetic magic the glass experiments may be brought to perfection. Since a small error at any time may upset the glass-maker's attempts, it is hardly surprising that the Assyrian craftsman should have used every magical effort to combat accident. This superstition of including bodies in the furnaces appears to have persisted for more than a thousand years, for we find Evagrius saying that a child was shut up by his father, a Jew, in a burning *clibanus* in which glass was made at Constantinople (Sixth Century A.D.).

In the construction of what is called 'the Furnace for Stone' there are two kinds of furnaces described. The first is called 'the Furnace with the Floor of Eyes' and the second 'the Furnace of the Arch'. The former is doubtless the name of the furnace which was discovered in the German diggings at Ashur and pictured in Andrae's *Coloured Ceramics*, fig. 37. As Mr. A. C. Pilkington suggests, the former was probably a high-temperature furnace,

⁵ See Gadd and Thompson, *Iraq*, iii, 87. By steeping the clay in vinegar and copper for three days *haṣḥallu* will be obtained. I thought, in *Revue d'Assyriologie*, 1934, 21, that this was something like 'leaves'; in *Iraq*, iii, 91, we took it to be 'bloom'. But it is a composite made up of two words, probably the same as the *haṣḥallat* (construct state), and I think I was wrong in seeing a simple word like 'leaves' in it; a composite word will hardly represent a simple expression. It occurs in the curious section of the *Gilgamesh Epic*, Tablet IX, v. 50, a description of a [magic (?)] tree, difficult to translate, but part of this description runs, apparently: 'red (-stone) bears its fruit [whatever may be the sense], it is pendent with foliage beautiful to see, and blue (-stone) bears its *haṣḥalta*'. In the present chemical text it would appear that the clay steeped in copper and vinegar, *i. e.*, verdigris, will produce *haṣḥalta* after three days.

In the medical texts we find *haṣḥallat* of the *SE.MUR* fruit tree (unknown), of the *illaḥḫu* (lemon?), of the pomegranate, of the medlar, of the (blackberry) bramble, and of *Acorus calamus* L. (*Assyr. Med. Texts*, 72, 1, rev.), and of the apple and of the fig (*ib.*, 55, 4), in both recipes to be bound as poultices. If *haṣḥallatu* be split up into two possible component words, the second is obviously connected with *hallu*, vinegar, and the first might well be cognate with the Syriac *hâṣ*, 'spissatus est' (Berthelot, *La Chimie au Moyen Âge*, ii, 22, 21); in other words 'inspissation of acid', the inspissated fruit (?). This exactly expresses the result of the three-day steeping of copper and vinegar as a green and acid liquid. Such inspissation may be compared with Pliny's prescriptions, in the case of sour pomegranate, external (*Nat. Hist.*, xxiii, 58), figs (a decoction, *ib.*, 63), and quinces (a decoction, *ib.*, 54).

and the latter perhaps a re-heating or annealing furnace. The most careful directions are given for the kind of fuel to be used, and how it is to be kept dry; the fire is to be 'good', 'not smoky', 'fierce', and it may be kept burning in one case up to seven days. The melting pots are to be 'clean', and apparently may be 'closed' or not. The metal is watched as it melts, turning red, yellow, or white. The implements used include a rake, and perhaps a ladle (?) and a slide (?). The texts begin with a formula for a simple frit, made of 10 parts of sand, 15 parts of alkaline plants and $1\frac{2}{3}$ parts of some gum, probably styrax, for which last inclusion I am unable to suggest an explanation. Perhaps some practical glass-maker can help us out in this. Next comes a blue copper glaze, made with 10 *manas* of *zuku* (a clear glaze made of an unknown amount of sand and 12 *manas* of *ahussu*, an unknown substance) and 10 *manas* of copper.

It is obvious that many chemicals can be identified from these recipes, since the formulæ must be much the same as those used to-day. For instance, there is the word *abnu amna(k)ku*, and the two words *tuskû* and *lulû*, which can be shown respectively to be the glass-maker's sand and the two kinds of oxide of zinc known to the ancients. These occur in the recipe for *dušû*, which means properly 'crystal':

20 mana of *abnu amnaku*,
 60 mana of salicornia-alkali,
 2 mana of *mil'u* (saltpetre),
 $\frac{1}{6}$ mana of *namrutu* (lime),
 1 mana of *tuskû*.
 $\frac{1}{10}$ mana of *lulû*.

abnu amna(k)ku is obviously the chief component here, as in the other glass formulæ, and will be the glass-maker's sand, not without a curious similarity in sound to the Greek *ἀμμοκόνια*, a calcareous sand.

The alkali, so Mr. Searle tells me, is in far too large a proportion, the proper amount, reckoned as sodium oxide, being about 15-22 parts to 100 parts of sand. If, however, we take it that the Assyrian chemist has given his quantity in the raw, and not after it has been reduced to ash, the proportion will probably be correct⁶.

Saltpetre, *mil'u*, is the Hebrew *mēlah*, salt. In Assyrian the ordinary word for salt is *tābtu*, distinct from *mil'u*, for which, from these texts and elsewhere, we must provide a special meaning.

Namrutu, lime, is the Arabic *nawrah*.

Tuskû and *lulû* are both difficult words. In the Assyrian vocabularies *tuskû* is described as 'crust of copper' and 'dust of copper': in the medical

⁶ For instance, wheat-straw gives 4.4 per cent. ash and pea-stalks 5.947 per cent., so that we may expect the alkali plants to give us something similar, let us say approximately 5 per cent.—that is, 5 per cent. of 60 *mana* will be 3 *mana*, that is, 15 parts to the 100 parts of sand prescribed in our text.

prescriptions it is recommended for use in eye-trouble, and for a cough to make the patient vomit. Zinc coincides excellently with these demands; it is used to-day in eye-salves, and in the case of a cough sulphate of zinc is used to make the patient vomit (Quain, *Dict. of Medicine*, 1883, i, 311: J. C. Booth, *Encyc. of Chem.*, 96, says that salts of zinc are an emetic).

Its mention as a form of 'copper' suggests its origin in the founders' furnaces, and it is amusing to note the same phraseology as the Assyrian in Stillman's *Story of Early Chemistry*, p. 10, that zinc ores 'were used in the manufacture of brass, and the term "cadmia" seems to have been applied to such ores as well as to the oxide of zinc obtained as crusts or dust from the brass furnaces'. As I have already mentioned, the Sumerian $S\bar{U}.H\bar{E}$, 'that which falls in the dome' (i. e., furnace), is probably the heavier form of oxide of zinc, the spodos which falls to the bottom of the furnace, in contrast to $K\bar{U}.H\bar{E}$ ('the $K\bar{U}$ of the dome'), which must be the lighter pompholyx. $K\bar{U}.H\bar{E}$ is definitely given as *lulû* in Assyrian; it is included in the Assyrian dictionaries in what may be called the cadmia group; it is used in eye and ear prescriptions, and as a styptic on wool for menorrhagia; and its propinquity to *tuskû* in the glass texts is indicative: but, most interesting of all, the sign $K\bar{U}$ = *šimru* (Rawlinson, *Cun. Ins.*, v, 21, 21, g), which, although given the meaning of 'Gewünschtes (?)', Schönes, Reichthum' in Bezold's *Glossar*, must surely here be cognate to the Heb. *sēmēr*, 'wool', allows us to see in $K\bar{U}.H\bar{E}$ 'wool of the dome', i. e. *lana philosophica*, all completing very strong evidence that this is the lighter form of oxide of zinc. Consequently our glass-formula works out at:

20 parts sand,	
60 parts of raw alkali, brought down to about 3 parts, when burnt,	
2 of saltpetre,	
$\frac{1}{6}$ of lime,	
1 of spodos,	
$\frac{1}{10}$ of pompholyx,	}
	oxide of zinc.

The word *tuskû* may perhaps be the origin of the modern tutty (tucia, tutie).

But the most important recipe in this series is the one described as producing [*baḥ(?)*]-*ri-e*, which I take to mean 'red coral' (*DACG*, 172), which suggests that the Assyrians knew the method of producing the Purple of Cassius by the introduction into glass of a minute quantity of gold, which has hitherto been considered as an invention of the Seventeenth Century A.D., the quantity of gold employed being to-day about 0.05 to 0.06 per cent.

The Assyrian text is unfortunately imperfect, and only half the word for 'gold' survives in it, and yet I think we may reasonably infer its employment. The formula runs:

60 shekels of *zuku*-glaze (=about 99.26 per cent.),
 16 carats of oxide of [*zi*]nc [*tus*]*kû* (=about 0.44 per cent.).

10 carats antimo[ny] (*aba[ru]*) (=about 0.27 per cent.),
 ... of saltpetre.
 $\frac{1}{2}$ carat of go[ld] (*KÛ.[GI]*) (=about 0.014 per cent.).

This last is the essential, and, as will be seen, only half the word is there. But the infinitesimal quantity suggests that it can be nothing else but gold⁷.

Enough, therefore, of the glass texts. We can go on to the identification of certain minerals.

There is, for instance, an interesting substance called *kibir-īlū ID*, 'bank of the river'. It is used in the medical texts for scab or itch in the head, and in fumigation for the sake of its evil smell, doubtless, primarily, to drive away demons, although probably the pungency of the drug may have played its part in reviving the patient. It was through the suggestion of Miss A. M. Lunn, B.Sc., that it was identified with sulphur, which fits it in every way, the modern treatment for scabies being with this drug, and the mediæval method of driving away demons being through similar smells. *Kibir-īlū ID* would appear to be the origin of the Assyrian *kibritu*, which allows us to refer the two to the cognate Arabic *kebrit*, sulphur, and so 'matches'. Actually the brimstone at Mosul comes from the river Tigris, where it is picked out at Hammam 'Ali, where are the sulphur medicinal baths (the *kebrit aswad*, or black sulphur), while the yellow brimstone comes from 'Ain Kebrit. These two kinds are similarly distinguished in Assyrian by the words *kibir-īlū ID*, the black, as contrasted with the *ru'ut-īlū ID*, *kibrit īlū nāri aruḫtum*, 'spittle of the river, yellow brimstone of the river'. Another word, formed similarly, 'dung of the river', is used for bitumen.

Take also a curious and interesting identification of a mineral in a love-charm. Powder of a mineral, *ṣadānu-ṣabitu*, mixed with oil is to be anointed on [the sexual part of] the man, and powder of iron similarly on the woman. The literal meaning of *ṣadānu-ṣabitu* is 'the hæmatite [iron ore] which grasps', i. e., magnetic iron ore, used here obviously with the intention of attracting the iron filings. There is an interesting parallel in more modern magic, told by G. F. Kunz (*Curious Lore of Precious Stones*, 96), of a negro woman in Georgia, some fifty years ago, who sued a conjuror for five dollars which she had paid him for a piece of lodestone to serve as a charm to bring back her errant husband.

We can now turn to the Assyrian 'hardness scale', the prototype of that which modern mineralogists use. I need hardly explain that the modern scale consists of ten degrees, starting with talc as the softest and ending with the

⁷ The three other possibilities of chemical words beginning with *KÛ* are *KÛ.BABBAR* silver, *KÛ.PAD.DU*, a salt, and *KÛ.ḪÊ*, pompholyx, a word which I had not considered as possible in *DACG*. In this latter case these chemical texts always spell out the word in Assyrian *lu-lu-u*. Moreover, whatever the possibilities, the quantity indicated is infinitesimal.

diamond as the hardest. We can arrive at the Assyrian scale in the following way :

There are three classes of blue stones :

Sumerian *abnu*ZA.GÌN⁸, Assyrian *abnu*uḫnû,
 „ *abnu*ZA.GÌN.AŠ, Assyrian *abnu*šipru,
 „ *abnu*ZA.GÌN.AŠ.AŠ, Assyrian *abnu*šipru.

Note the additions AŠ and AŠ.AŠ, which occur also with a group of white stones, as we shall see later :

Sumerian *abnu*PAR,
 „ *abnu*PAR.AŠ,
 „ *abnu*PAR.AŠ.AŠ.

Now *abnu*ZA.GÌN, *abnu*uḫnû, has long been known to mean lapis lazuli (hardness 5·5-6·0), the soft blue stone often powdered to make a blue paint. There is no doubt about its meaning, since it is the word used actually to describe two small lapis discs of the Kassite Period (middle of the Second Millennium)⁹. But it also appears to have the meaning of turquoise (hardness 6·0). Indeed, in order to describe what is probably the turquoise of Persia, an Assyrian historian appears to have used the same word for it as for lapis. On the other hand, it may be that the turquoise of Sinai is indicated by the word *abne*tirûti, perhaps the Arabic *firûz*. It is, however, on the third word *šipru* that our explanation of the hardness scale chiefly depends.

Philologically *šipru* suggests the word 'sapphire', and that this is correct will at once be obvious when we consider the Assyrian root *šapâru* 'to scratch', whence *šupru* 'finger nail', the Heb. *šippôrên*, which is used in Jer. xvii, 1, in the phrase *šippôrên šâmîr*, 'point of emery' (*smiris*). Indeed, in one vocabulary in Assyrian *abnu*šipru is given as the equivalent of *abnu*kunnu[ku], 'the seal-stone', not the stone from which seals are made (which is hardly reasonable, in view of the large number of the different stones from which seals were made), but the stone for cutting seals, *i. e.*, corundum (of which sapphire is a form).

Here, then, we have the second hardest stone in the modern list, and the hardest of all that were known to the ancients, its figure in the modern list being 9·0 out of 10·0; consequently we may see in *abnu*ZA.GÌN.AŠ.AŠ,

⁸ More correctly, perhaps, *abnu*IA₈(?).GÌN. I cannot help thinking that this word, which represents the colour 'blue', literally 'mountain-stone', has taken its name from the blue of the distant mountains of the Persian Frontier as seen from Mesopotamia. I noticed this during the War when coming up the Tigris from Basrah, when the Persian hills first came into view on the horizon.

⁹ Jensen suggested its equivalence with *cyanus*, the Syr. *ḫuna'a* (philologically to be paralleled by the Assyrian *šamnu*urnû, 'mint', Syr. *nan'â*); it may also be cognate to *hyacinthus*.

as *šipru*, the hardest blue stone, 9·0, as contrasted with *abnu*ZA.GÌN, lapis, with a hardness only of 5·5 to 6·0. The intermediate *abnu*ZA.GÌN.AŠ, which is also given the value *šipru*, 'sapphire, corundum', is explicable, if we assume that the Assyrians were not too clear in their distinction between the lapis, turquoise and sapphire, a point borne out by their word *abnu*šipir ħuraši, 'golden sapphire', which, like the 'sapphire with spots of gold' of Pliny (*Nat. Hist.*, xxxvii, 38, 39), cannot be a sapphire at all.

If we apply this explanation of a simple scale as marked by the addition of AŠ and AŠ.AŠ similarly to the white stones, we shall find the same system; *abnu*PAR occurs but rarely (it means *abnu*amna[*ku*], 'siliceous sand'); *abnu*PAR.AŠ is probably alabaster or feldspar (hardness 2 or 6 respectively); and *abnu*PAR.AŠ.AŠ will then be chalcedony (hardness 7·0).

There would therefore appear to have been a simple hardness scale in existence marked by the addition of the signs AŠ and AŠ.AŠ after certain minerals (the blue and white stones). It does not recur in stones of other colours, but, as we shall see, is used also for definitely sedimentary white stones as well. This brings us to another of the mineralogists' tests, that of acid on sedimentary rocks.

That the Hebrews were aware of something of the effect of acid on natron is shown by Prov. xxv, 20, 'as vinegar upon nitre'. Pliny (*Nat. Hist.*, xxiii, 27) says that the hard stones met with in the mines are broken by means of fire and vinegar, and, indeed, although the tradition of Hannibal and the Alps may be fantastic, such a belief may well have grown out of a more simple trade secret. The Syriac *Book of Medicines* (12th (?) century A.D., ed. Budge, ii, 186) speaks of pouring 'strong acid' on the ground and taking the seething mud.

In discussing this we have to consider two uses of the mineral group *abnu*ZA.ṬU¹⁰, which occurs

- (1) as an independent mineral;
- (2) as a prefix to certain white and green stones.

That there are these two separate usages is certain; and most noteworthy is it that one example of the latter use in a Sumerian incantation written with an interlinear translation in Assyrian (*Cun. Texts*, xvii, 39, 48) ignores this prefix entirely in the Assyrian version. This gives the translation for *abnu*ZA.ṬU.MUŠ.GIR as if it were the simple and well-known *širgaru* (*mušgaru*) stone, which is usually written in Sumerian as *abnu*MUŠ.GIR (without prefix).

Take *abnu*ZA.ṬU first as an independent mineral.

In the Assyrian vocabularies this Sumerian word is given the Assyrian value *ḫulalu*, which may be referred to the root *ḫalālu*, which would

¹⁰ Or perhaps read *abnu*IA_u(?)ṬU.

appear to occur already in Assyrian in the composite word *hašhallatu*¹¹ and in the cognate Syriac word *hallâ* 'vinegar', which appears also in post-Assyrian times. Next, *abnu*ZA.ṬU is found in the vocabularies with the addition of the word BE, 'roasted', the whole (*abnu*ZA.ṬU BE) having the Assyrian value *sâsu*. Now this value *sâsu* would appear to be shown in the cognate Syriac *sâsgûnâ*, *purpureus*, the latter part of the Syriac word being *gûnâ*, 'colour', so that we may consider our Assyrian word *sâsu* as equivalent to the Syriac [*sâs*] 'red'.

If we split up ZA.ṬU into its components, ZA represents the word for mineral, and ṬU (in its meaning *šakâlu*, 'to weigh', *šapâlu*, 'be low') suggests 'heaviness'. In historical texts the mineral *abnu*ZA.ṬU is rare, but it does certainly occur, *e.g.*, in descriptive lists of decorations by Sennacherib (*Bavian*, 27), 'red mineral, blue mineral, green mineral, *abnu*ZA.ṬU, *abnu*PAR.AŠ (alabaster, or similar)'; in *Keils. aus Assur*, ii, 122, 52, 'silver, gold, red mineral, blue mineral, *abnu*ZA.ṬU, green mineral, *abnu*PAR.AŠ (alabaster, or similar), *abnu*PAR.AŠ.AŠ (chalcedony, or similar), orpiment (yellow)'; from these quotations there would be no *prima facie* objection to seeing in it a form of paint as a decoration (parallel certainly to the blue, ultramarine), and that a white one.

Next, in Assyrian medicine the powder of *abnu*ZA.ṬU is prescribed to be anointed on the temples in oil (*Cun. Texts*, xxiii, 41, 1). There is also a special form, *abnu*ZA.ṬU.IGI, 'ZA.ṬU for the eye' (or, 'of the eye').

We have therefore evidence for a mineral which would appear to be connected with acid, is heavy, perhaps a white paint, used on temples, with a special form for the eyes; and when it is roasted it becomes red. White lead would appear to comply with all this; it is formed from the action of acid on lead, is a heavy white paint, is recommended, *e.g.*, by Ibn Beithar, on the forehead as an embrocation, and for eyes. When roasted it becomes red, as was well known to the ancients (*e.g.*, Pliny, *Nat. Hist.*, xxxiv, 54).

So far, then, we may have solved *abnu*ZA.ṬU as an independent mineral—white lead. What is its other meaning, when attached as a prefix to white and green minerals?

As I pointed out above, the Assyrian translator in his poetic version has in one case certainly omitted to stress that this prefix affects the meaning of a certain green mineral. The explanation of this may lie in his ignorance that the presence or absence of this prefix marked the distinction between two different green stones. But whatever the explanation of this apparent lapse may be, it is, I think, obvious that this prefix, which in one of its meanings I take to be white lead, should give some special meaning to other minerals when it is thus prefixed to them, and this can surely only suggest that some distinction in meaning from 'white lead' is in such instances attributed to it. What will this meaning be?

¹¹ See note on p. 6.

The outstanding value for *abnu*ZA.ṬU, *ḫulalu*, is, as we have seen, in its reference to its *acid* connection. If we set aside for the moment its particular value as 'white lead', and concern ourselves only with its connexion with acid when it represents a prefix added to certain minerals, the suggestion at once comes that it is the well-known mineralogist's test of sedimentary rocks by the application of acid. It is prefixed to *abnu*MUŠ.GIR, 'the serpent stone', which is (without the prefix) serpentine (*cf.* Boson, *Riv. d. Studi Orientali*, 1916, vii, 407), similar to the Greek ὄφιτης; *abnu*ZA.ṬU.MUŠ.GIR would appear to be the name of the green stone used in making cylinder seals. Similarly *abnu*ZA.ṬU is affixed to the two white stones *abnu*PAR.AŠ and *abnu*PAR.AŠ.AŠ (which I take to be alabaster (gypseous sulphate) or feldspar, and chalcedony respectively). If the prefixed *abnu*ZA.ṬU indicates that the green and white stones effervesce with acid, we can then see in these respectively (for the green) malachite as contrasted with serpentine, and (for the white) calcite and aragonite (or magnesite) as contrasted with gypseous alabaster (or feldspar), and chalcedony. If so, we may consider that the Assyrians had an acid test for certain stones, which, after all, is not difficult to believe of so scientific a nation. Indeed, it is possible to see in another similar word, *abnu*ZA.NIM, which also has the value *ḫulalu*, a still closer indication; NIM represents a fly or other winged creature, which suggests a buzzing or hissing ('the buzzing mineral'), amusingly paralleled by the plant-name *šammu*ZID.NIM, 'the NIM (buzzing, hissing?) powder', equated in the vocabularies (*Cun. Texts*, xiv, 34, K.4565, 24, restored from *Cun. Texts*, xxxvii, 30. ii. 33, and from a photograph of VAT. 9000 given me most courteously by Prof. Ehelolf) with *šammu*sagilatu, an alkali, *i. e.*, one of the components of soap (*i. e.*, 'the powder of (hissing) lather').

Now let us look at what the old alchemists called vitriols. This is, of course, the old word used for certain metallic sulphates.

First we must consider the two words which the Assyrians had for stones producing fire. The first, *šurtu* and *šurru*, have been rightly identified with the Hebrew *šorr*, 'flint' for knives. The other is more important for our purpose, and in the vocabularies heads the list of what will be seen to be the vitriols.

Its name *aban iṣati*, 'stone of fire', is given the synonym *pindû*, which has the meaning of a disease of the head, and a white form of it is called *garabu*, 'leprosy'. In other words, it probably represents our *herpes*, 'an eruption of vesicles', which, as 'fire-stone', can hardly mean coals or flint; it must be the granulated pyrites, which is aptly comparable to the disease.

Now this word pyrites heads the list, as I have said, of the words which will be seen to mean vitriols, and I will take these in order, although I am compelled to anticipate a little by discussing the particular form which one of them takes, *abnu*ZUR.ŠÁR.GUB.BA.

This word *abnu*ZUR.ŠÁR.GUB.BA in the vocabularies precedes *abnu*marḫušu, which is practically our word marcasite (the Syriac form is

mark'šithā). It follows *abnušamaitum*¹², which means 'the heavenly blue', which at first sight, since we are on the track of the vitriols, suggests the blue vitriol, the sulphate of copper, with its beautiful blue colour.

This word *abnuZUR.ŠAR.GUB.BA* is based on a form of mineral *abnuŠAR.GUB.BA*, and in order to reach the meanings of the words for vitriols we must try to identify this simple form through a third and more elaborate form, *abnuGI.RIM.ŠAR.GUB.BA*. This is the name of one of the substances or articles used by Sennacherib in his account of his adornment of his palace in Nineveh (see *Archæologia*, lxxix, pl. lii, 122, N.), and he compares it to the pomegranate. Here, then, we can formulate a suggestion for the meaning of the word; *GI.RIM* is well known as the spherical calyx of a flower, and it refers particularly to those stone column-bases ornamented thus as flowers. If so, we have a spherical mineral resembling a calyx, and likened to the pomegranate, found in relation to the vitriols. In other words it is the large yellow pyrites, which the old *Penny Cyclopædia* (xiii, 29) says is frequently found in the form of various fruits. It is in my recollection that I have at Nineveh dug out something of the kind which I erroneously took to be something like mediæval cannon-balls, but which not improbably were these decorations of Sennacherib.

If, then, *abnuGI.RIM.ŠAR.GUB.BA* be the decorative spherical pyrites like pomegranates, *abnuŠAR.GUB.BA* must be a word for simple pyrites. What, then, is *abnuZUR.ŠAR.GUB.BA*?

In the list of vitriols in the Assyrian vocabularies *abnuZUR.ŠAR.GUB.BA* is given the Assyrian value *ianibu*. Since *abnuŠAR.GUB.BA* is pyrites in some form, and we are dealing, as we have postulated, with the vitriols, we should suspect *ianibu* to be the Assyrian name for the green vitriol produced by the decomposition of pyrites. Can we prove it?

We find in these vocabularies an equivalent given for *ianibu*, the Sumerian *abnuZA.SUH.SIG*₇¹³, i. e., 'green *ZA.SUH*', which is getting us nearer. We can also compare the word *ianibu* to its Semitic cousin, the Hebrew word 'énâb, 'grape', in connection with Pliny's description of chalcantum, *atramentum sutorium*, under which name he probably includes green vitriol (*Nat. Hist.*, xxxiv, 32, with Bostock's note), the result of steeping cords in reservoirs in the manufacture of chalcantum; 'a slimy sediment attaches itself to the cords, in drops of a vitreous appearance, somewhat resembling a bunch of grapes'. *abnuZUR.ŠAR.GUB.BA*, as *ianibu*, will represent green vitriol, as made from the decomposition of pyrites; and hence, since *ZUR* means in general 'destruction' (*naharmutu*), and 'corpse' (*pagru*), we must see in the whole word 'decomposition of pyrites', green vitriol.

¹² Actually *abnušamaitum* is given a synonym, *abnumušiltum*, which suggests a corruption of the Syriac *māsīdīn*, *vitriolum cuprinum*. Pliny's *cæruleum*, copper ochre, blue carbonate, is a philological parallel (*Nat. Hist.*, xxxiii, 57).

¹³ Or *abnuIA*₈(?)*.ŠUH.SIG*₇.

*abnu*ZA.SUH occurs also in the word *abnu*ZA.SUH.DIR, 'red ZA.SUH', which will suggest colcothar, the red oxide of iron obtained by heating green vitriol.

Finally, in the same group of vitriols we find our word *abnu*marḫušu (related to our word marcasite), given as equivalent to *ḥannabahru*, a composite word occurring only once, which would appear to be made up of two words, *ḥannu*, which may be cognate to words in other Semitic languages for 'fœtidity', and *bahru*, a well-known Assyrian word for 'steaming', *i. e.*, suggesting that we have here the Assyrian for the fuming oil of vitriol obtained in roasting green pyrites.

So much for some of the words for vitriols.

There is an interesting word for a pseudo-meteorite, the sulphide of iron, *abnu*saggilmūt, which is included near these words for vitriols. Its occurrence in a historical text is important: Esarhaddon (680–668 B.C.) says that he went to

'Bazu, a district of remote situation, a journey of desert, a land of salt (and) a place of thirst, 120 double hours of sandy ground, thistles and loadstone, where snakes and scorpions like ants filled the ground; 20 double hours of the land of Ḥazû, mountains of saggilmūt-stone, I left behind me'.

All the indications show that this is the district in Arabia of Eastern Nejd, and we may thus have to look for the saggilmūt-stone in E. Arabia.

In an Assyrian omen we find 'If it thunders in the month of Tammuz, and lightning which like saggilmūt-stone leaps forth from the midst of the sun', which at once suggests that we are dealing with a true meteorite. In the vocabularies it is given as equivalent to what must be a little spherical slingstone. Now, if we turn back to Esarhaddon's description of E. Arabia, we find it stated by the geologist Pilgrim (*Mem. Geol. Surv. Ind.*, 1908, **34**, 101) that the limestone of Qath (Oman) is full of iron nodules, and Carter (*Journ. As. Soc. Bengal*, 1859, 41; 1860, 239) that the Arabic coast of the Persian Gulf is a sedimentary formation resting on volcanic rocks associated with beds of rock-salt, gypsum, pyrites, specular iron ore, etc. It appears, therefore, that not only have we the true meteorite, but the pseudo-meteorite, the nodule of iron sulphide, such as are found in the chalk in England. The Assyrian soldiery must have held the modern belief about these nodules.

It is interesting to see the Assyrian word *muṣû* taken over by Greek and Roman authors in the form *misy*, either sulphate of copper or iron. It occurs in Assyrian medical prescriptions about fifty times, used fairly often for applications to the eyes and temples.

Arsenic is represented by numerous words, either for orpiment or realgar, the Assyrian containing a reference to 'gold' or 'yellow' paint. The Sumerian form *abnu*AŠ.GE₄.GE₄ becomes in Assyrian *ašgikû* (which would seem to be allied to the Arabic *šakk*, 'arsenic'), and this is interesting because of the idea

involved in the word AŠ. The plant ^{šammu}AŠ is *asafætida*, an alliaceous plant, and the connexion would appear to be in the property of arsenic, when roasted, of giving off an alliaceous smell. A second equation for *ašgikû* is *inib karaši*, 'fruit of leek', which, as well as the alliaceous connexion mentioned above, suggests the description given in the old *Penny Cyclopædia* (ii, 404) 'of a curved lamellar composition, exceedingly like the layers of an onion', for native arsenic.

Although this by no means exhausts the list of our words for Assyrian chemicals and minerals, I think I had better stop with one more only, the word for pumice, *aban kašari*, the Syriac *ḵsrâ*, which was taken over into Greek as *κί ηρις*. The Sumerian form ^{abnu}BALAG.GÁ means 'the drum-stone', the explanation being from the use of pumice in preparing the parchment. It is also called *aban elligi*, 'barber's stone', *i. e.*, for smoothing the skin, just as Pliny says (*Nat. Hist.*, xxxvi, 42) that pumice is used for imparting smoothness to the skin of females, and not females only, but men as well. A third name for it is 'the pen-stone', *i. e.*, for sharpening reed-pens. Finally, we can see the word *kašari* in the Assyrian name of the mountain west of Assyria, *Kašari*, which by a very usual metathesis of the liquid *r* recurs in the modern name Karaja Dagħ. Here lava is found (W. W. Smyth, *A Year with the Turks*, 74), as also at Bitlis (Ainsworth, *Travels*, ii, 369), while pumice is said to be plentiful in the volcanic district N. of Assyria (Loftus, *Quarterly Journal of the Geological Society*, 1855, 314), so that I think there is no doubt that the Mt. Kašari of the Assyrians is 'the pumice-stone mountain' and the modern Karaja Dagħ.

'BOYLE'S LABORATORY.'

By RICHARD B. PILCHER, O.B.E.

[PLATES I-VII.]

THE Hon. Robert Boyle, at the age of 20, *circa* 1646, had intended to work at Stalbridge, but unfortunately his large furnace was broken in transit, and he seems to have been so distressed about it that he paid little attention to chemistry for a few years. In 1652 he went to Ireland, but he complained that he was unable to pursue chemistry there, and it was not until 1654 that he joined his friends of the 'Experimental Clubbe' at Oxford, where he remained, working with Willis, Wilkins, Wren and others, until 1668. About that time he settled in London with his sister Katherine, Lady Ranelagh, in Pall Mall, in the neighbourhood of Spring Gardens—near the present Admiralty Arch—where he had a laboratory with a staff of assistants. Later, however, he is said to have instituted the laboratory, illustrated in Plates II-V, at Maiden Lane, Southampton Street, between Covent Garden and the Strand, which, in due course of time, came under the control of Ambrose Godfrey, who had previously had charge of the laboratory at Apothecaries' Hall.

Ambrose Godfrey was the son of Boyle's operator, Ambrose Godfrey Hanckwitz (Plate VI), whose two sons, Ambrose and Boyle, dropped the name of Hanckwitz.

Hanckwitz had become noted for the manufacture of phosphorus; indeed, it was said that he practically monopolized the European market in that commodity; and, later, Ambrose Godfrey (Plate VII) invented and sold a 'bomb' fire-extinguisher, in which phosphorus was an important ingredient: it was claimed that it suffocated the flames.

The laboratory, however, has commonly been described as 'Boyle's Laboratory'. Boyle's transference to Maiden Lane is referred to in Gunther's *Early Science in Oxford*¹; but, if one considers the extent of the operations indicated by the size of the apparatus, it would appear to have been essentially a manufacturing laboratory; and, certainly, in the course of time, it became the laboratory of the business continued under the style of Godfrey and Cook, manufacturing chemists, throughout the eighteenth and nineteenth centuries, until about 1862.

¹ Part I, *Chemistry*, Oxford, 1921, 21, in a quotation from the *Journal of the Oxford Junior Science Club*, 1892, 118.

Much of the equipment of this laboratory was reproduced in a fine series of separate plates, by Gravelot and Toms. Probably all the apparatus and plant was to be found on the premises of Godfrey and Cook ; but, no doubt, changes took place and, in the *Universal Magazine*, in 1751, there was an illustration of one side of this laboratory, described as ' Third View of Practical Chemistry ', which was subsequently printed² with the addition of representations of various forms of apparatus and ' An Account of the Chemical Laboratory '—a key to the picture here reproduced as Plate II.

1. A reverberatory furnace for distilling oil of vitriol, &c., with thirty-two long necks. *a, a, a, a*, the receivers. *b, b, b, b*, the necks of the long-necks, the bodies being placed within the furnace, *c*, the fire-place. *d*, the ash-hole.
2. A large furnace, in which flowers of sulphur are sublimed in a great quantity. *a*, the fire-place. *b*, the ash-hole. *c*, a door into the body of the furnace, by which the flowers are taken out.
3. A melting furnace. *a, b*, two small doors to the fire-place, to be opened occasionally, when it is necessary to inspect the matter acted on by the fire, or to add fuel. *c*, a large door, to be opened when a crucible is to be set in or taken out of the furnace.
4. A pelican, or circulatory vessel.
5. A subliming furnace. *d*, the body of the furnace. *a*, the body into which the matter to be sublimed is projected. *b, b, b*, three aludels. *c*, the head.
6. A tubulated retort.
7. A body and head.
8. An adopter (*sic*). *a*, a glass vent-tube fitted to its small end.
9. A retort.
10. A melter's horn, or antimonial cone.
11. A commodius (*sic*) apparatus for making spirit of sulphur. *a*, a large retort with a hole in its bottom. *f*, a tubulated receiver, with the spout upwards. *e*, a glass mortar. *d*, a concave glass plate, with a hole in the middle. *e*, a gallipot inverted over the perforation in *d*. *b*, a crucible containing burning sulphur.
12. A German crucible.
13. A muffle.
14. A black lead crucible.
15. A cupel or coppel.
16. An alembic head.
17. A blind head.
18. An adopter (*sic*).
19. A receiver.
20. An earthen long-neck for distilling oil of vitriol, &c.

² The writer has not traced the source of this picture. The copy from which it was prepared was marked, in pencil, ' Account of Chemical Laboratory—published 1769 '. The same illustration occurs in *The New Complete Dictionary of Arts and Science*, by ' The Rev. Mr. Middleton &c. ', plate xvii, but it is not from the same plate.

21. A furnace for digestions, &c.
22. A furnace for distilling harts-horn in quantity. *B*, the furnace, containing an iron pot. *c*, an earthen head. *b*, *b*, two receivers.
23. A furnace for distilling with a retort on an open fire. *d*, a coated retort placed in the furnace.
24. A furnace for distilling in *balneum mariæ*. *D*, the furnace, containing an iron pot filled with water. *c*, the vessel, containing the ingredients placed in the water. *d*, a glass head. *c*, a receiver.
25. A small furnace for boiling syrups, &c.
26. A furnace for melting, boiling, &c. *M*, the bellows. *f*, a glass body in a copper vessel filled with water, placed over the furnace.
27. A furnace for making spirit of sal ammoniac, &c. *G*, the furnace. *a*, a retort placed in the furnace. *g*, a large receiver.
28. An apparatus for procuring the volatile salt of sal armoniac, &c., in a dry form. *k*, a retort placed in the furnace. *i*, an adopter. *b*, a receiver.
29. A sand heat, with a retort and receiver.
30. A coldestill (*sic*). *n*, the head. *o*, the receiver.
31. An open furnace for extracting volatile salts, as from vipers, &c. *q*, a coated retort placed in the furnace on an open fire. *p*, the receiver.
32. A furnace for digestions, tinctures, &c. *f*, a vessel, containing the ingredients to be digested. *r*, a blind head.
33. Two stills at work with one common refrigeratory. *a*, the body of the largest still. *b*, its head. *f*, the receiver. *e*, the body of the smallest still (*sic*). *d*, its head. *g*, a spout receiver for separating oil from water.

The terms applied to different forms of apparatus appear not to have been always consistent; for example, an alembic might be a vessel like a retort with a short curved outlet or it might be the helm or head of a still.

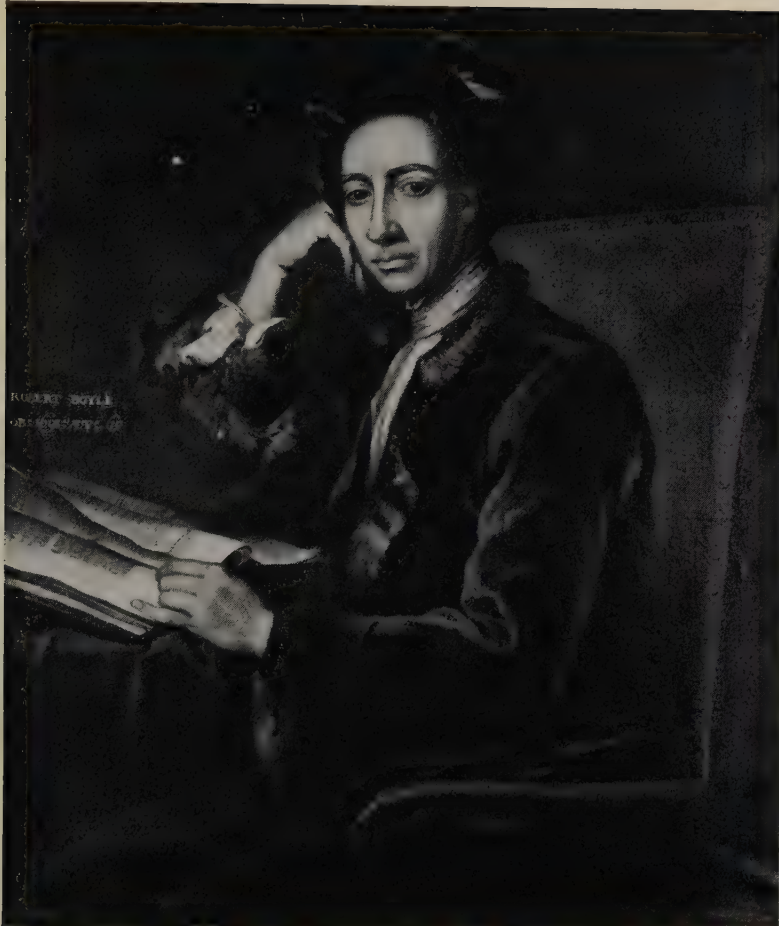
An aludel, according to the William Johnson's *Lexicon Chymicum* (London, 1652-3), was a kind of subliming pot, but the same term was used to describe a section of condensing apparatus. The *athanor* or furnace was built of brick or stone, and was apparently provided with dampers to control the draught and heat. A *piger Henricus*, or slow Harry, was used when moderate heat was required; a *furnus acediæ* was a tower furnace (*turris circulatorius*). A *bolt-head*, sometimes called an *ampulla*, was a receiver,—a round-bottomed flask, with a long tapering neck for receiving the distillate. Round-bottomed flasks rested on circular pads of straw or rope. A *crosslet* was a crucible, or pot for use in melting metals. The *cucurbit* was a container, usually of glass and of gourd-shape, used as a retort. A *matrass* was a glass vessel, with a round or oval body and a long neck, used for digesting or distilling. *Muffles*, clay liners for furnaces, were much the same as those we now use. *Separating apparatus* for separating water from oil was known. A *pelican* was a retort with a beak-like delivery tube; sometimes it had two tubes, when it was described as a circulatory vessel.

The *water-bath*—*balneum Mariæ*—or *bain-marie* and sand-baths were early in use for gentle heating, and the *equi clibanum*, which derived its warmth from horse manure (*finus equinus*) was employed for a steady gentle heat without fire,—similar to the modern hay-box.

A tube of glass or metal was sometimes called a *trunk*; and an *egg* was an egg-shaped distilling vessel.

An interesting feature is the arrangement of the pestle and mortar on the left-hand side of Plate IV. The pestle is tied to a pole fixed securely at the other end, so that the pestle is kept in a vertical and manageable position and springs up of its own accord, thus relieving the operator of the labour of lifting it. A similar arrangement is shown in old drawings illustrating Oscar Guttman's *Monumenta Pulveris Pyrii* (1906), and in an engraving by Stradanus (1536–1604). There was also one at Apothecaries' Hall less than forty years ago; but in other pharmaceutical establishments a strong steel spring was introduced, instead of the pole, to exert the lifting power. In fact, two such arrangements—with springs—appear to be indicated, though not very clearly, on the far right-hand side of Plate V.

From records of his work, we know that Boyle had all the usual apparatus available in his time—furnaces (in which he sometimes burnt peat), stills and condensers, retorts and receivers, muffles, crucibles and cupels, thermometers, burning-glasses, spirit-lamps, and an air-pump—but, whether or not he worked in this laboratory, the illustrations clearly show apparatus in great variety employed on a fairly large scale. For example, 'The reverberating furnace for distilling oil of vitriol, with 32 long necks', illustrated at the bottom of the left-hand side of Plate II, also shown in Plate III, would surely produce more acid than Boyle was likely to require for his philosophical experiments, and the furnaces and stills, vessels, sieves, the weighing-beam suspended from the ceiling, and other accessories, indicate that, when the drawings for these illustrations were made, the laboratory was in use for manufacturing purposes.



THE HON. ROBERT BOYLE (1626-1691).

This portrait of the Honourable Robert Boyle (1626-1691), in the Library of the Institute of Chemistry, is attributed to Jonathan Richardson, Senr., a contemporary of Kneller and Dahl,—early eighteenth century. Richardson was born in 1665; he left many portraits unsigned; this has been pronounced by several authorities as undoubtedly his work. It bears the dates of Boyle's birth and death (1626-1691) and was probably posthumous. However, names and dates were often added to portraits long after they had been painted.

The portrait resembles the engraving of a bust by Faber and bears a close likeness to Boyle's sister, the Countess of Ranelagh, at whose house in London he lived and worked for many years.

It has been objected that few of the nobility and gentlemen of the time of Charles II and James II were painted otherwise than in court dress. Portraits showing gentlemen in dressing-gowns and velvet caps appeared more frequently about 1720, when Boyle had been dead nearly 30 years; but it may be suggested that Richardson preferred to represent him as a philosopher in his study. Towards the end of his life Boyle lived very quietly in the country, and did not frequent the court.

The picture was purchased at a sale at Loudon Castle, Galston, Ayrshire, and acquired for the Institute, by private subscription, in 1931. It is interesting to note that Lady Jean Boyle, who died in 1729, was the wife of the third son of the second Earl of Loudon, a lieutenant-general in the army in 1743.

PLATE II.



‘BOYLE’S LABORATORY’ (see Key, pp. 18–19).

PLATE III.

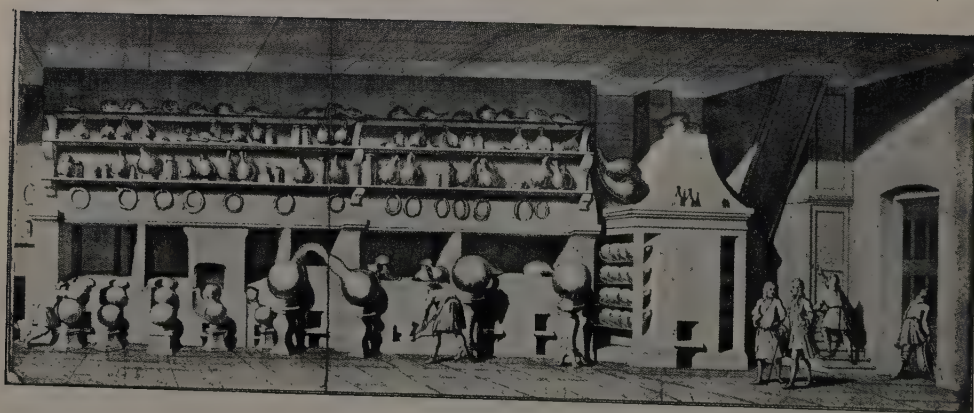


PLATE IV.



PLATE V.



PLATE VI.



AMBROSE GODFREY HANCKWITZ
(1660-1740 or 1741).

PLATE VII.



AMBROSE GODFREY
(c. 1685-1756).

SOME REMARKS ON HERMES AND HERMETICA.

By Prof. Dr. EDMUND O. VON LIPPMANN*.

THE following remarks are intended to supplement in several directions the statements on Hermes and Hermetica in my *Entstehung und Ausbreitung der Alchemie* (2 vols., 1919 and 1934)¹ and assume a knowledge of the material there collected.

1. The name Hermes occurs already in very ancient times as an earth god, 'possessing magic forces', among the Cilicians and Hittites, among the latter as Arma; the Greek Ἑρμαξ (Hermax) is related to this. Hermax was originally the designation of the heaps of stones or conical stones, the oldest form of the Hermæ, in which the god was worshipped². Much later, at the beginning of the Hellenistic period, the form Hermes Trismegistos appears, and was shaped and transformed under the influence of Oriental and Egyptian ideas; from the latter he was equated with the Egyptian god Thoth or Tehuti, already well known to Plato. Thoth was regarded as the personification of spirit and understanding, the master of speech and writing, the creator of mathematics and astronomy, the possessor of all knowledge, especially secret or occult knowledge, and the author of all existing books without exception. His surname Trismegistos, *i. e.* the thrice greatest, is explained as follows. In the old Egyptian texts the threefold repetition of the given hieroglyphic expressed the plural³, and later the superlative, so that 'Hermes the great, the great the great' is to be read 'Hermes the greatest', and not, as happened erroneously, as 'Hermes the thrice greatest', or Trismegistos. There is hence no relation with Trikephalos (τρικέφαλος = three-headed), a designation of the Hermæ, which is sufficiently evident from the fact that these were also sometimes called Tetrakephalos (τετρακέφαλος = four-headed). These Hermæ were placed at crossings of three or four roads, and were nothing but signposts; people who pretended to possess all parts of philosophy or other branches of knowledge were ironically designated by these expressions⁴. There is no greater analogy

* Abbreviations: *A. Rel.* = *Archiv für Religionswissenschaft* (Leipzig, 1902 ff.); *H.D.A.* = *Handwörterbuch des Deutschen Aberglaubens* (Berlin, 1927 ff.); *PW* = Pauly-Wissowa, *Real-Encyclopädie der classischen Altertums-Wissenschaft* (Stuttgart, 1894 ff.); additions in square brackets [] are by the author.

¹ i, 224; ii, 107.

² Brandenstein, *PW*, Suppl. vi, 181.

³ Erman, *Die Welt am Nil*, Leipzig, 1936, 25; Neugebauer, *Vorgriechische Mathematik*, Berlin, 1934, i, 85.

⁴ Kruse, *PW*, vA, 1076; cf. Eitrem, viii, 698 and 706 ff.; for an older view see Weber, *A. Rel.*, 1934, 31, 173.

with the surname Trimorphos (=three-formed) of a demon, which in any case appears only in the Byzantine period ⁵.

The magic papyri of the Hellenistic and following periods used as synonymous with Trismegistos the surnames Trismegas, Trismegalos (τρισμέγας, τρισμέγας), and later texts speak in exaggeration even of the 'Nine Times Greatest' ⁶. The Gnostics also equated Hermes Trismegistos with the Egyptian god Thoth ⁷; he taught the initiated the secret true names of the highest gods, which conferred complete mastery of them and the possibility of 'theurgic compulsion' ⁸. He composed a lapidary on the magic powers of stones, similar to the work of the so-called Bolos Demokritos, which is mentioned even in the ninth century by al-Râzî ⁹, and wrote the mystic *Koiranides of Hermes*, existing only in extracts and appearing to go back to sources from the Near East ¹⁰ from the first to the third century A.D.

2. The true so-called *Hermetic Books*, in which in part the old derivation is already forgotten, e. g. Hermes is designated as Father of Thoth, are of very miscellaneous content (religious, theological, philosophical, mystic-magical, astrological, etc.) and equally various ages. The earliest, according to Cumont ¹¹, are the astrological, which may have been composed about 150 B.C., whilst the very miscellaneous remainder ¹² apparently arose between 100 B.C. and 100 A.D.; the form, however, in which they present themselves to us was probably taken about the third century A.D. In any case, some portions of them, as, for example, the *Papyrus Insinger* of the first century A.D. shows, go back to quite early times ¹³, and influenced by so many tendencies (e. g. the equation of Thoth with 'Hermes the bearer of the keys of Hades') those 'dreams of the mystical philosophers' which appear, for example, in the famous book *Poimandres* ¹⁴. In the period between the second centuries B.C. and A.D. the Chaldean-Persian astrology assumed an increased importance, as can be seen from the so-called *Orphic Hymns* and the *Magic Papyri*, which appeared about this time but were later much altered; in these the very old relations of Hermes with the goddesses of fate, the Moiræ, are in part changed; these appear in co-

⁵ Delatte and Josserand, *Mélanges Bidez*, Brussels, 1934, i, 218.

⁶ Kazarow, *PW*, xv, 222; Roeder, *Altaegyptische Erzählungen und Märchen*, Jena, 1927, 171.

⁷ Rusch, *PW*, viA, 386.

⁸ Hopfner, *ibid.*, 258.

⁹ Wellmann, 'Marcellus von Side als Arzt und die Koiraniden des Hermes Trismegistos', *Philologus*, Suppl. Bd. 27 (Leipzig, 1934), 23 ff., 29 ff.

¹⁰ *Ibid.*, 15 ff., 19 ff.

¹¹ *Mélanges Bidez*, i, 144; cf. Gundel, 'Neue astrologische Texte', Munich, 1936, *Akad. d. Wiss.*, Heft 12.

¹² See *Hermetica*, ed. Scott (Oxford, 1926, 1936; Latin and Greek, 4 vols.); cf. *Isis*, 1937, 27, 119.

¹³ Edit. Boeser, Leyden, 1922; Erman, *Die Religion der Aegypter*, Berlin, 1934, 344.

¹⁴ *Ibid.*, 409, 403; 345.

ordination with their leader, the former 'Lord of the Universe'; they discover the seven vowels and with them the alphabet magic and mysticism, and possess the 'Oracle saying of the Universe' written on seven metal tablets named after the seven planets [as lords of the seven metals]¹⁵. Alchemical allusions also then acquire definite currency, and it is very worthy of note and apparently not previously pointed out, that the great and influential Stoic, Epiktetos (50–130 A.D.), makes the claim that: 'The power of the true staff of Hermes lies in the fact that it changes all which it touches into gold'¹⁶, by which, it is true, he had in mind the gold of the true philosophy, that is, his own.

3. As an important bearer of all the relations mentioned, Hermes appears also in high regard among the Fathers of the Church, the Scholastics, etc., and through them among the believing scholars and the superstitious unlettered, the influence reaching down to folklore¹⁷; in Italy, even in Rome, *Sanctus Hermes*, *Hermes catholicus christianus*, and *San-Mercurio* lived on into the fourteenth century as a saint, a patron of the Church and a magician, and so it happened elsewhere. In literature one of the first accurate students of the Hermetic wisdom was William of Auvergne (1180–1249), and following him were Petros Theoctonicos (after 1250), the versatile physician Nicolaus Polonus (after 1250)¹⁸, and many other scholars of the Middle Ages and the Renaissance; even Copernicus (1473–1545) quotes Trismegistos as saying that the sun is 'the visible god'¹⁹, and the outstanding physician Champier (1471–1537?), one of the most indefatigable promoters of the Platonic movement originating in Italy, in the preface to his *Miroir des apothiquaires*, speaks of Hermes Trismegistos as of equal value with the Bible and Aristotle²⁰. Similarly, Croll in 1647, in his *Hermetischer Probiere Stein* praises Hermes as 'Hermes, the earliest theologian'²¹. In fact, even in 1784 this 'first philosopher' appears as evidence of the first order for the validity of alchemy, in a memoir of 126 pages by Schmidt²². Finally, it must not be forgotten that Sterne (1711–68) in his masterpiece *Tristram Shandy*²³ is able to choose for Shandy's son no more 'magnificent name' than Trismegistus, this 'greatest of all earthly beings', whose importance is assured by the fact that he was born by an operation (Cæsarian section) before it had a name.

4. Also in the East, especially when the Arabs had conquered Egypt and had begun to busy themselves with alchemy, Hermes stood in high regard

¹⁵ Kruse, *PW*, xv, 2498; Eitrem, 2473, 2484, 2488.

¹⁶ Nestle, *Die Nach-Sokratiker*, Jena, 1923, i, 88, ii, 207.

¹⁷ Peuckert, *H.D.A.*, Stuttgart, 1927 ff., iii, 1784.

¹⁸ Sarton, *Introduction to the History of Science*, Baltimore, 1927 ff., ii, 588, 1043, 1092.

¹⁹ Zinner, *Geschichte der Sternkunde*, Berlin, 1931, 457.

²⁰ Mönch, *Fortschritte der Medizin*, 1933, 51, no. 41.

²¹ Croll-Hartmann (Frankfurt, 1647), 48.

²² *Magazin für höhere Naturwissenschaft und Chemie*, Tübingen, 1784, i, 88.

²³ London, 1760–1767. Vol. ii, ch. 19; vol. iv, chs. 8, 11, 14.

with his wisdom, especially alchemical, which had 'come from Adam' and had finally been laid down in the *Tabula Smaragdina*. On the one hand the Arabs had received from the Ssabians of Harran the writings of Hermes as the 'greatest old Greek philosopher' ²⁴, and on the other hand they accepted from the first the traditional belief holding in Egypt that the pyramids were nothing but stacks of immense treasures and the pictures and hieroglyphic inscriptions on their walls were instructions in 'secret knowledge', both astrological and alchemical, that is in the preparation of gold and silver. Even Edrisi (al-Idrîsî, 1099–1166), who composed his famous *Geography* in the Norman court in Sicily in 1154, says of this:

'In Alchmim [in the neighbourhood of the eastern bank of the Nile] one sees a building called al-Berba, which was erected by the glorious Hermes before the Flood. He foresaw, in virtue of his arts, that the world would be destroyed by a catastrophe, although he did not know whether by fire or by water. For this reason he first built walls of earthy matters, free from combustible parts, and covered them with pictures and scientific emblems, so that, in case the world perished by fire, they would remain and even gain in solidity, so that those who came after could read the inscriptions. Then, however, he caused a building of the hardest stone to be erected, providing thereby for the presentation of all sciences useful to man, and said: "In case the catastrophe by water occurs, the buildings of earth will fall, but these [of stone] will remain and preserve science from destruction". When now the Flood occurred, everything happened as Hermes predicted. Buildings of the same kind are found also in Esna and Denderah, but those in Alchmim are the most solid and are most remarkable by the number of their pictures, which represent not only the stars but also the different arts, and further the number of inscriptions is very great' ²⁵.

Later reports sound even more fantastic. In the *Spangles of Gold* of Ibn Arfa' Ra (d. 1197) it is said, for example, in an excerpt made in 1200–50 and contained in an *Epistle on the Light of the Process of the Hermes of all Hermes*, that Hermes is a 'generic notion', the real name is Ahmûn, that is Henoch, who is again the same as Idris, the son of Adam. His home was China, from whence he came by way of India to Ceylon, and discovered the Cave of Hermes; it contained immense treasures, a portrait of father Adam, and the most beautiful gems, among them a quite exceptionally large and costly one [obviously the *Tabula Smaragdina*; the emerald was the gem associated with Hermes]. The further account is concerned very obscurely with all kinds of alchemical technical terms; it speaks of whitening, reddening, diplosis, sublimation, distillation, sulphur, mercury, sal ammoniac, black and white smoke, and different substance sand poisons under cover-names, relations to planets, *e. g.* Saturn, etc. ²⁶.

²⁴ Horten, *Die Philosophie des Islam*, Munich, 1924, 66.

²⁵ *Géographie*, transl. Jaubert, Paris, 1836, i, 125.

²⁶ Sigge, *Islam*, 1937, 24, 287, translation, 299.

A keen adherent to Hermism was the excellent mineralogist Bailak of Cairo (1242–82)²⁷; a century later the famous traveller Ibn Battuta praises Hermes, who is no other than Enoch and Idris, as a 'wise man of old' and builder of the pyramids, in the inscriptions of which he had laid down his secret knowledge²⁸.

²⁷ Sarton, *op. cit.*, ii, 1072.

²⁸ Transl. Defrémery and Sanguinetti, Paris, 1854, i, 80.

ALCHEMY DURING THE FIRST HALF OF THE SIXTEENTH CENTURY.

By LYNN THORNDIKE.

JUST as almost no alchemical treatises had been printed during the period of incunabula, so they appeared but slowly in the sixteenth century. One reason for this may have been the prejudice against Arabic and mediæval Latin authors which prevailed in the fields of medicine and astrology and the lack of any authentic texts of ancient Greek writers in the field of alchemy comparable to Galen, Hippocrates and Ptolemy, to which one could turn back. The dubious name of Hermes was all that alchemy had to offer by way of a focus for a classical revival. So for the most part alchemy remained relatively quiescent in laboratory and manuscript¹ until the Paracelsan revival of the second half of the century. There was, however, a gradually increasing publication during the first half of the century.

Hieronymus Brunschwig's work on distillation which had been first printed in 1500 continued to reappear in further editions during the sixteenth century. Four of the alchemical treatises ascribed to Arnald of Villanova were included in the *editio princeps* of his works, published at Lyons in 1504. Repeated editions of Arnald's collected works during the first half of the century attest the popularity of his medicine and its pre-Paracelsan association with alchemy, astrology and magic. A not unfavourable attitude towards alchemy and the possibility of the transmutation of metals was shown in the influential general textbook, the *Margarita philosophica*, of which the first edition appeared in 1503. In stating that water can be turned to stone by being congealed by cold or coagulated by mineral virtue as it falls drop by drop, it cites Raymond Lull in the *Lapidary*, one of the alchemical works attributed to him. A few other alchemical authors and works are named: Hermes, Geber, Avicenna, the *Turba philosophorum*, Albert, and Arnald of Villanova. The elements are said to be altered into one another or into compounds. Glass is made of herbs or sand. So there is no reason why metals may not be transmuted except that it is difficult for art to imitate nature. Those who promise riches to princes never succeed, and one should beware of such deceivers, who always remain poor themselves.

¹ That there was a widespread circulation of alchemical literature in manuscript form is suggested not only by the number of extant MSS. of the fifteenth century, but by the score and more of different alchemical authors and treatises cited in the letters in German of an alchemist of Lausitz from 1496 to 1506. See W. Ganzenmüller, 'Briefe eines Lausitzer Alchemisten aus den Jahren 1496-1506', *Zeit f. angewandte Chemie*, 1935, 48-49, 761-4.

An alchemical tract by Ludovicus Lazarellus or Lodovico Lazzarelli of San Severino near Naples, which is preserved in a Riccardian manuscript at Florence², is an entirely different work from his *Crater Hermetis*, which was first printed in 1505 and is not alchemical. The two share, however, the feature of a common interest in Hermes, whose *Emerald Tablet* is soon cited in the alchemical tract. Lazarellus says that his teacher in alchemy was John Richard de Branchiis of Burgundy, who began to instruct him in 1495 and who himself had become proficient in the art from reading the works of Raymond Lull and Arnald of Villanova and from long practice. From this it would seem likely that Lazarellus writes after 1500, and the handwriting of his tract seems of the early sixteenth century. He sets forth the usual alchemical process of calcination, solution, purification, projection and multiplication in seven chapters. He cites Picatrix as author of the *Clavis sapientiæ*, a title more often associated with the name of Albertus Magnus. He speaks of astrological images and celestial magic, in which Zoroaster excelled, and cites Thebit and Ptolemy, presumably as names to whom books of such images were ascribed.

The same manuscript further contains a 'treatise of master Raymond Lull to his dearest nephew on investigation of the stone', which is, so far as I know, the earliest occurrence of this particular work of the Lullian alchemical corpus³. After it follow excerpts from Lullian alchemy 'in volgare'⁴, chemical tables⁵, a sonnet in Italian on alchemy⁶, and a secret recipe for the elixir

² FR 984 (Lami, III, xx), paper, octavo. On the title page is written: 'Lud. Lazereli, Raym. Lulli et Io. de Branchis Tractatus de Alchimia'. On the recto of the next leaf is an Index in which the first entry is, 'Ludovici Lazareli Vade mecum h. e. tractatus de alchimia'. This treatise occupies fols. 1r-8r and opens, 'Hermes theologorum magorum alchimistarumque pater uno verborum contextu . . .'

³ FR 984, fols. 8v-16v: titulus, 'Incipit tractatus magistri Raymundi Lulli ad nepotem suum carissimum de lapidis investigatione'; incipit, 'Scito quod sapientes in miraculo lapidis posuerunt multas operationes . . .' Captions indicative of the contents are:

fol. v, Quomodo philosophi reliquerunt quod non est nisi unus solus lapis
 Quomodo spiritus lapidis habet potentiam vivificandi corpus
 9r, Preparatio
 9v, Quomodo aqua secunda capiatur per se
 Quomodo flegma capiatur per se
 10r, Quomodo calcinetur terra
 Quomodo acqua secunda rectificatur
 10v, Tabula subtilitatis iacet in hoc capitulo extrahendi animam a corpore
 12r, Sequitur lapidis vivificatio
 12v, Ut spiritus congelatus in sulfur extrahatur a terra
 13r, Quod lapis est corpus æreum spirituale et corporale
 15r, De fixatione aeris in quo continetur tintura (*sic*)
 De tintura et fixatione lapidis cum aere
 15v, Alius modus levior cerandi elixirii
 16r, Alius modus creandi (?) elixirii.

⁴ FR 984, fols. 18r-33r.

⁵ FR 984, fols. 17r-18r, with an exposition of them at fols. 34v-45v.

⁶ FR 984, fol. 36r.

invented by the aforesaid de Branchiis, now called John Rigaud de Branchis, when he was in Siena in 1494, with the co-operation of Albert, a physician of Perugia⁷. This secret John had revealed to Lazarellus with his own mouth. Lazarellus therefore appears to have been responsible for the putting together of this alchemical manuscript in its entirety.

An alchemical poem which was composed in the early years of the sixteenth century was the *Crisopeia* or *Chrysopæia* of Johannes Aurelius Augurellus. Pavanello, who has given an analysis of it with quotations⁸, is of the opinion that Augurellus began it about 1500, and there are references in it to the siege of Padua in 1509. The first edition, however, was at Venice in 1515⁹. Three years later Froeben issued another at Basel. The poem was dedicated to Pope Leo X, whose Mæcenate in Medicean Rome extended to alchemy as well as poetry, as we shall see again in the case of Pantheus in 1518, and whose credulity embraced yet other occult arts than that of transmutation.

The interest in Raymond Lull at Paris at the close of the fifteenth and beginning of the sixteenth century among men like Jacques Lefèvre d'Étaples, who in 1491 was reading Lull on contemplation, and Charles Bouvelles, whose life of Lull was written in 1511 and printed at Paris in 1514, seems hardly to have extended to the alchemical writings attributed to him. In Spain, however, the Cistercian, Jacobus Januarius, in his *Ars metaphysicalis naturalis ordinis*, published at Valencia in 1506, not only expounded the Lullian art but accepted the Lullian alchemical writings as authentic¹⁰. The printing of works from the Lullian alchemical collection seems first to have started in 1514 when, together with medical works of Giamatteo Ferrari da Gradi, Maimonides and Arnald of Villanova, was printed the *De secretis naturæ* or work on the fifth essence of 'the sacred doctor, Raymond Lull'¹¹. It com-

⁷ Fr 984, fols. 33v-34r: 'Arcanum elixeris de inventione magistri Ioannis Rigaudii de Branchis quod ipse Senarum in civitate fecit in societate magistri Alberti Perusini phisici anno 1494 anno ante adventum in Italia Caroli octavi regis Francorum. Quod arcanum ipse magister Joannes mihi ex maxima sui liberalitate ore proprio revelaret. Accepit primo succum lunarie septies distillatum . . . / . . . secundum numerum algorismi in projectionem ad perfectionem deducit. Deo gratias.'

⁸ G. Pavanello, *Un maestro del quattrocento*, Giovanni Aurelio Augurello, Venice, 1905.

⁹ Dorothea Waley Singer, *Catalogue of Latin and Vernacular Alchemical Manuscripts in Great Britain and Ireland dating from before the XVI Century*, 1930, ii, 557-58, Item 815, is mistaken in representing the *Chrysopoeia* as printed at Verona in 1491. The volume of poems then published by Augurellus (*Gesamtkatalog der Wiegendrucke*, 2861) did not include it, as Ferguson, *Bibliotheca Chemica*, i, 56, has already pointed out.

¹⁰ Ivo Salzinger, *Beati Raymundi Lulli Opera Omnia*, Moguntiae, i (1721), Testimonia virorum illustrium, pp. 6-7: 'Carolus Bovillus, Vita Lullii scripta a. 1511 ed. Parisiis typis Ascensianis a. 1514 quam Benedictus Gonon inseruit Vitis Patrum Occidentis, ed. Lyons, 1626, Lib. 6.'

¹¹ Joh. Math. de Gradi. *Consilia*, Venice, 1514, fols. 103r, col. 1-113v, col. 1: 'Incipit liber prime distinctionis secretorum nature seu quinte essentie sacri doctoris magistri Raymundi Lulli de insula maioricarum . . .'

prised the preliminary dialogue with the monk, opening, 'Contristatus erat Raymundus . . .', and the Lullified version of Rupescissa's work on the fifth essence, opening, 'Deus gloriose cum tue sublimis bonitatis ac infinite potestatis . . .' It did not include the *Tertia distinctio* nor the concluding Disputation with the monk. This was also the case in an edition of Augsburg, 1518. For a score of years and more thereafter the *De secretis naturæ* seems to have been the only treatise printed from the Lullian alchemical corpus. But it was re-issued several times. There was an edition of 1520 which fails to specify its place of publication, another of 1521 at Venice, and a third at Lyons in 1535, this time again with the *Consilia* of Giamatteo Ferrari da Gradi, a fourth by Ryff at Strasburg in 1541, a fifth at Venice in 1542, and a sixth at Nürnberg in 1546.

In an edition of the work of Albertus Magnus on minerals at Oppenheim in 1518—it had already been printed four times in the fifteenth century—its semi-favourable discussion of alchemy was counteracted by a concluding exhortation of Virgilius of Salzburg against alchemy in the form of six verses in German, with the Latin headings, 'De alchimie phantastica fatiga Exhortatio Virgilii Saltzburgensis' and 'Ne studentes alchimie splendori sese occupent rhythmos curavi subscribere vulgares'.

Apparently the only alchemical incunabula known are two of works ascribed to Geber, one containing the *Summa perfectionis magisterii*, *Liber trium verborum* and *Investigatio magisterii*¹², the other a *Flos naturarum* of 1473¹³. There was a lull in Geberian publication during the first quarter of the sixteenth century, until about 1525 Marcellus Silber issued at Rome an edition similar to that by Eucharius except that the *Testament* of Geber was added to the other three works, while the non-Geberian contents of the earlier volume were replaced by Avicenna on minerals. Something more closely resembling the earlier edition appeared at Strasburg in 1529 and 1531, while a printing at Venice, 1542, was more like that of Marcellus Silber. Meanwhile, in a larger and more inclusive volume, which was printed at Nürnberg in 1541 by J. Petreius, Geberian alchemical treatises were combined with medieval Latin authors in that field: the *Speculum alchemiæ* ascribed to Roger Bacon, the *Correctorium* of Richard of England, the *Rosarius minor*, the commentary of Hortulanus on the *Emerald Tablet* of Hermes. In 1545 Geber appeared in print again at Berne.

But we must turn back chronologically to 1518 again to consider a work

¹² Hain 7505, Pellechet 5004, *British Museum Catalogue of Books Printed in the Fifteenth Century*, iv, 124. At Rome by Eucharius Silber, date uncertain.

¹³ Hain 7504; E. Darmstaedter, 'Die "Geber"-Inkunabel Hain 7504', *Archiv für Geschichte der Medizin*, 1925, 16, 214–17, knew of copies only in Jena and Vienna. Though containing some alchemical recipes, the work deals chiefly with magico-medical uses of parts of the human body, also with unlucky days. Darmstaedter doubted if its author may be identified either with the writer of the *Summa perfectionis* or with the Jabir ibn Haiyan of Berthelot.

by a contemporary. Johannes Augustinus Pantheus, a priest of Venice, published there on December 30, 1518, an *Art of Metallic Transmutation* with a permit from the Council of Ten and an edict of Pope Leo X¹⁴, dated the last day of February, 1517, giving him the exclusive right of printing the work in the Papal States. The work is also dedicated to Leo. In view of the reported prohibition of the practice of alchemy by the Venetian government in 1468 or 1488¹⁵—to which we shall find Pantheus himself referring in a later work—it is surprising that the Ten sanctioned this publication in 1518. Our Pantheus or Panteo was possibly the son of Joannes Antonius Pantheus of Verona, who composed a work on hot baths in the region around Verona¹⁶ and died in 1497.

In his preface to the Pope, Pantheus describes his booklet as very recently put together from varied reading of the philosophers. He wishes it to contain the sincere truth of the secret of transmutation, to abolish deceits and incredulity, to reveal the stone to the sons of wisdom and to conceal it from the ignorant. Reading his book would have saved those who have followed false interpretations all their time and expense. Similarly in a second preface to the reader he promises to elucidate completely this most weighty theme of the transmutation of metals. Actually he succeeds only in making the matter more mysterious by various charts, diagrams and columns of letters and numbers as well as the Tetragrammaton and Greek and Hebrew characters. After the manner of the Lullian alchemical treatises he sets letters for stages in the process of transmutation and gives diagrams of the four elements and primary qualities. There is a pageful of names which he says all signify the same thing. Numerical equivalents are given for the different letters of the alphabet, and the totals are added up at the base of the columns. In addition to this mystic reckoning, such tremendous secrets are imparted as that the first principle of nature is matter and that the second principle is heat. Fire and water are represented on the authority of Morienus and of Albertus 'in libro perigeneseos' as the two principal elements from which air and earth are generated. It is explained that air is generated from the heat of fire and the moisture of water, while earth comes from the dryness of fire and the coldness of water combined.

Other alchemical authorities cited are Hermes 'in his allegory', which concerns a crow and hence would hardly seem to be the *Emerald Tablet*, and

¹⁴ On the title page, 'Ars transmutationis metallicæ cum Leonis X ponti. max. et concii. capi. decemvirorum Venetorum edicto'; colophon, fol. 38v, 'Commentarium transmutationis metallicæ Io. Augustini Panthei sacerdotis Veneti sub Leone X pontifice maximo ac Leonardo Laurentano optimo principe in ædibus Ioannis Tacuini impressorum accuratissimi Venetiis editum tertio Kalen. Ianuarii MDXIX.'

¹⁵ Lynn Thorndike, *Magic and Experimental Science*, iv, 349, n. 76.

¹⁶ *Confabulationes de thermis quæ in Veronensi agro sunt, in De balneis omnia quæ extant*, Venetiis apud Iuntas, 1553, fols. 110–41. The treatise takes the form of a dialogue between the author, Hermolaus Barbarus, and Aleardus de Indemontibus or Pedemontius, a physician of Verona. In the printed catalogue of the Bibliothèque Nationale, Paris, vol. 129, p. 859, the two Pantheus's are confused under a single designation.

' in his *Secret*, namely, the Vine (or, Staff) of the Wise ', the *Turba philosophorum*, Geber, Alphidius, the author of *Perfectum magisterium*, the author of *The Three Words*, Ioannitius, Avicenna, Rhodanus, Rosinus and Vincent. Some of these Pantheus could have consulted only in manuscripts.

After the *Art of Metallic Transmutation* ends with the date, September 7, 1518, there follows in our edition a new title-page inscribed, ' Commentary of the Theory of the Metallic Art of Transmutation '. It is addressed to a noble Pole named William Hyerosky. In it Pantheus alludes to ' those Institutes of ours edited in former years ' and over which he has heard that Hyerosky pores day and night. He denies that these Institutes were incomplete as published and left something for verbal interpretation like the cabala. But he now explains what his Hebrew characters represent and the numerical value of some letters. He adds some recipes, then reverts to columns of numbers in his closing pages. It is at the close of this Commentary that we find the final date of publication, December 30, 1518. It is not quite clear whether by the title, Institutes, Pantheus refers to the preceding *Ars transmutationis*, which may have circulated in manuscript form for some time before being printed, or to some other earlier production of his.

It seems probable that, after the publication of this volume of 1518, someone called the attention of its author or the Papal Court or the Venetian government to the existence of a papal decretal and a decree of Venice against alchemists. For in 1530 Pantheus brought out with the same printer at Venice a book entitled *Voarchadumia contra alchimiā: ars distincta ab archimia et sophia*. As this title suggests, he now professed to be writing not on alchemy but on Voarchadumia, an art distinct from alchemy. This Voarchadumia he represents as true wisdom, the very opposite of alchemy, a sort of ' cabala of metals ', handed down from Tubal Cain through the Chaldeans and Indians. Alchemy he now execrated in agreement with the *Extravagans* of Pope John XXII opening, ' Spondent quas non exhibent divitias pauperes alchimiste . . . ', with the constitution against counterfeiters of the Emperor Constantine, and with the decree of the Council of Ten against alchemists with the addition beginning ' Tollenda sunt de medio . . . '. With this disavowal Pantheus again obtained permission to print from the Apostolic Legate and the Council of Ten, and the work opens with prefaces to the Doge and to the papal legate. Yet he repeats most of his work of 1518 in the course of the *Voarchadumia*. The volume also includes woodcuts of alchemical furnaces and apparatus and a bird's-eye view of Venice and its surroundings. Both the *Voarchadumia* and the work of 1518 were reprinted together at Paris in 1550, and again, but omitting both the papal edict and the preface to the Pope, in the second volume of Zetzner's *Theatrum chemicum* as published in 1613 and in 1659.

The last publication by Pantheus which we have to note is astronomical rather than alchemical, being a *Lunario perpetuo* printed at Venice in 1535,

but still has this interesting connexion with gold-making, that the author is described as not only a priest but a 'refiner of gold of Venice' ¹⁷.

In 1530 in the first edition of his sceptical work on the uncertainty and vanity of the sciences, Henry Cornelius Agrippa, after having occupied himself with alchemy in 1507 at Paris, in 1509 at Avignon, and in 1518-19 at Metz, declared that the art should be prohibited. Then he rather spoiled the effect of this assertion by adding that he might say things concerning this art, which had not been altogether unkind to him, were he not sworn to silence after the custom of those initiated into mysteries. It was three years later that Symphorien Champier published his letter against alchemy. A correspondent of Agrippa in 1531 cited the work to which we next turn, the *Cælum philosophorum* of Philip Ulstad ¹⁸.

According to Graesse and Ferguson this *Heaven of The Philosophers* of Philip Ulstad was first printed at Fribourg in Switzerland in 1525, but Gesner states that it was composed there in that year but printed at Strasburg in 1528 ¹⁹. The British Museum catalogue, however, lists an edition of Strasburg, 1526, as well. In any case the work became very popular and was frequently published thereafter both in Latin editions and in French and German translations ²⁰. The full title states that the work was drawn from such authors as John of Rupescissa, Raymond Lull, Arnald of Villanova and Albertus Magnus ²¹. It is chiefly concerned with the fifth essence, its extraction and modes of distillation, and so would seem to owe the most to John of Rupescissa. Potable gold and *aqua vitæ* also receive considerable attention. In the preface, dated 1543 in the edition of 1544 which I used, Ulstad says that the Lullian alchemical corpus is as yet little known ²². The *Cælum philosophorum* appeared in French translation at Paris in 1546 and 1550 ²³. Between these dates Rupescissa's work on the fifth essence was printed at Lyons in French trans-

¹⁷ Giov. Agostin Pantheo (De Vinegia Affinatore de oro et sacerdote), *Lunario perpetuo con la dimostrazione della scala della Epacta*, etc., Vinegia, 1535.

¹⁸ Agrippa, *Epistolæ*, vi, 32.

¹⁹ Conrad Gesner, *Bibliotheca universalis*, Tiguri, 1545, fol. 559r.

²⁰ Listed by John Ferguson, *Bibliotheca Chemica*, Glasgow, 1906, ii, 482-3.

²¹ I have used an edition of Paris, 1544: *Cælum philosophorum seu secreta naturæ id est quomodo non solum e vino sed etiam ex omnibus metallis fructibus carne ovis radicibus herbis et aliis quam plurimis quinta essentia sive aqua vitæ ad conservationem humani corporis debeat educi. Liber tum medicis ac chirurgis tum pharmacopolis imo et omnibus sanitatis retinendæ studiosis pernecessarius. Ex variis authoribus Ioanne de Rupescissa Raymundo Lullio Arnaldo de Villanova Albertoque Magno a Philippo Ulstadio adiectis clarissimis figuris collectus.* 95 fols.

²² 'Ad paucorum enim manus pervenisse video Mercuriorum librum aut Testamentum aut Codicillum aut reliquos Raymundi libros.'

²³ *Le ciel des philosophes où sont contenuz les secretz de nature et comme l'homme se peult tenir en santé et longuement vivre . . . extrait des livres de Arnould de Villeneuve du grand Albert Raymond Lulle Jehan de la Roche Tranchée et plusieurs autres bons auth. de nouveau trad. de latin en française*, Paris, 1546 et aussi 1550.

lation in 1549²⁴, whereas the first complete Latin edition of it under Rupescissa's name, as distinct from the Lullified version of it published under the name of Raymond Lull from 1514 on, was that by Gratarolus at Basel in 1561²⁵. Ulstad is said by Gesner and Ferguson to have been a patrician of Nürnberg who taught medicine at Fribourg. A pest tract by him was printed at Basel in 1526²⁶.

In a volume of medical opuscula published by Joannes Petrus Arlunus in 1532 that author speaks well of an alchemical remedy of the fifth essence or potable gold²⁷, thereby perhaps showing the influence of the *Cælum philosophorum*.

The discussion of metals by Mathesius at Wittenberg in 1540 did not concern itself with the subject of their transmutation and so is omitted here. Certain publications in German, although having the word alchemy in their titles, dealt primarily with practical arts: *Alchimia, Das ist Alle Farben Wasser Olea Salia und Alumina*, printed at Strasburg in 1539 by Cammerlander, and *Rechter Gebrauch d'Alchemei mitt vil bissher verborgenen nutzbaren vnnnd luxtigen Künsten*, first printed in 1531, then as *Künstbüchlin* with additional recipes in 1537, 1538, and subsequently^{27a}.

The *Pirotechnia* of Vannuccio or Vannoccio Biringuccio or Biringucci seems to have been first printed in 1540, after which there were several other editions before the end of the century²⁸. *Pirotechnia* is not the full title²⁹, and the text deals chiefly with metals and little with fireworks and artillery. The opening chapter is sceptical as to the possibility of transmutation. In general the book impressed me as a sixteenth century version in Italian of what one might find in Latin works of the three previous centuries³⁰.

²⁴ *La vertu et propriété de la grande essence de toutes choses, faite en latin par Ioannes de Rupescissa et mise en françois par Antoine Du Moulin*, Lyon, J. de Tournes, 1549, 156 pp.

²⁵ *Joannis de Rupescissa qui ante cccxx annos vixit de consideratione quintæ essentia rerum omnium opus egregium*, etc., Basilæ, 1561.

²⁶ Philipp Ulstad, *De epidemia tractatus*, Basilæ, 1526, 8vo: copy at the British Museum 1167.c.6. (1.).

²⁷ *Index operis Io. P. Arluni . . . De faciliiori alimento summula. De faciliiori alimento tripartitus commentarius. De potu balnearum commentarius. De lotii difficultate commentarius. De articulari morbo. De spirandi difficultate. De seminis fluore. De febre quartana. De suffusione*. Milan, G. Pontius; V. Gauoti impendio. 116 fols. Copy used: BM 544.k.1. The volume is a beautiful piece of printing with wide margins. The passage cited occurs in *De lotii difficultate* at fols. LXIVv-LXVr.

^{27a} John Ferguson, *Bibliotheca Chemica*, 1906, i, 19; ii, 246.

²⁸ The recent edition of 1914 by Aldo Mieli gives only a fraction of the work, less than two of its ten books.

²⁹ The full title runs: *De La Pirotechnia Libri x dove ampiamente si tratta non solo di ogni sorte & diversita di Miniere ma anchora quanto si ricera intorno a la prattica di quelle cose di quel che si appartiene a l'arte de la fusione ouer gitto de metalli come d'ogni altra cosa simile a questa. Composti per il S. Vanoccio Biringuccio Sennese*, Venice, Venturino Roffinello, 1540.

³⁰ For a more enthusiastic estimate the reader may turn to Icilio Guareschi, *Vannochio Biringucci e la chimica tecnica*, 1904.

In 1542 was printed at Paris the work of F. Remaclus or Remaclus Fuchsius of Limburg entitled *A History of All Waters which are in common use to-day among practitioners, their virtues and the correct method of distilling them*. A treatise on spices and aromatics accompanied it ³¹. He also, Tiraqueau says, wrote a *Method of Curing Syphilis* (*Methodus curandi morbi Gallici*) and a nomenclature of plants ³². He further published *Lives of Illustrious Physicians* who flourished and wrote during the previous century ³³, so that distillation was only one of his interests.

Fra Ambrogio Quistellio was an Augustinian who lectured at Padua on the Pauline Epistles and Gospel of St. John, and then was called to Rome as Procurator-General and subsequently Vicar-General of his order, dying there July 9, 1545. He is said by Vedova ³⁴, who seems to follow Scardeone in this, not only to have held that long study of Aristotle was not essential to an understanding of the Bible ³⁵, despite which he commented upon *De generatione et corruptione*, but to have composed a work on the vanity of alchemy. It is not noted in the alchemical bibliographies of Ferguson and Bolton, and probably remained in manuscript.

The name of Chrysogonus Polydorus appears in the 1541 and 1545 editions of works of Geber as that of the editor. Gratarolus, writing in 1561, had no doubt that the editor's real name was Osiander ³⁶, presumably the same person who put Copernicus, *De revolutionibus*, through the press. His preface affirms the truth of transmutation. It is stated that Aristotle and Theophrastus wrote on metals, although these works are no longer extant. In any case later writers who have followed reason and experience have greatly advanced the subject and probably have outdistanced whatever Aristotle and Theophrastus may have discovered.

Giovanni Bracesco of Brescia in 1544 published at Venice his exposition of Geber in dialogue form in Italian. It appeared in Latin translation at

³¹ F. Remaclus, *Historia omnium aquarum quæ in communi hodie practicantium sunt usu vires et recta eas distillandi ratio. Accessit conditorum (ut vocant) et specierum Aromaticorum quorum usus frequentior apud pharmacopolas tractatus, etc.*, Parisiis, J. Foucher, 8vo.

³² Tiraquellus, *De nobilitate*, 1566, cap. 31.

³³ Remaclus Fuchsius, *Illustrium medicorum qui superiori sæculo floruerunt ac scripserunt vitæ*, Paris, 1541, 12mo. Allut, *Étude biographique et bibliographique sur Symphorien Champier*, Lyons, 1859, p. 250, describes the work as 'petit in 8vo Parisiis apud Petrum Gromorsum sub Phœnice, 1542'. The printed catalogue of the Bibliothèque Nationale, Paris, lists two editions, both 'apud P. Gromorsum' and in octavo, but one of 1541 and one of 1542.

³⁴ Gius. Vedova, *Biografia degli scrittori padovani*, 1832-6, ii, 143-4.

³⁵ Ambrosius Quistellius, *Adversus philosophus qui asserunt divinam scripturam nequam posse percipi nisi ab his qui bonam vitæ partem in Aristotelis et aliorum philosophorum lectione contriverunt*, Venetiis, 1537. Cited by Gandolfo, *Diss. hist. de ducentis celeberrimis augustinianis scriptoribus*, Rome, 1704, p. 59.

³⁶ Yet Ferguson says, "I have found no indication of the author's real name". Federicus Chrisogonus Iadertinus was of course a different person,

Nürnberg in 1548 together with another dialogue on the mysteries of Lullian alchemy. The printer, Johannes Petreius, in a note to the reader alludes to his recent editions of works by Raymond Lull and Geber, whose hidden secrets these dialogues will now disclose. The same volume included a tract on the tree of life which Bracesco had first issued in Italian at Rome in 1542. This Latin version of Bracesco's dialogues was also printed at Lyons in the same year, 1548, while the dialogue on Geber was translated afresh by Gratarolus for his collection of 1561 entitled *Veræ alchemiæ* . . . etc. Gratarolus says in a preface that Bracesco was then seventy years old and had spent almost his entire life in alchemical studies poring over the books of the ancients. And the *Tree of Life*, as the dialogue is entitled, consists chiefly of citations³⁷. The leading idea of Bracesco, if it be his own, is that mercurial water, the gold of the philosophers, and mercury may all be produced from iron, which is that stone sold for a cheap price to which alchemical tracts constantly refer. Gratarolus also printed *Some Matters of Practice explained from Geber by the learned and most expert old man, Giovanni Bracesco*, a text of only two or three pages.

Robert Tauladanus in a letter of April 1, 1554, to John Michael Sterpinus from Turin refers to himself as a quite unknown youth (*adolescens*) of Aquitaine. His interest in alchemy led him first to Paris, then to Italy in order to see Sterpinus and Gaudentius Merula. When he reached Turin he learned that Merula was coming there to teach. Meanwhile he diverged to visit Sterpinus. He states that Merula had purged the text of the *Precious New Pearl* of Petrus Bonus, first published in 1546 in the version of Janus Lacinius, of more than three hundred errors. When Tauladanus saw Merula at Turin, he asked his opinion of the recent dialogue, *Lignum vitæ*, of Giovanni Bracesco. Merula at first did not like to say what he thought, but finally admitted that he had no very high opinion of Bracesco's work and encouraged Tauladanus to write out his criticisms of it. Tauladanus also sought out Bracesco in Italy, but the latter answered him in riddles or in a manner not to his taste. Returning to France, Tauladanus composed his *Animadversions Against Giovanni Bracesco, the Interpreter of Geber*. He was especially offended at Bracesco's seeking the philosophers' stone from iron. Tauladanus frequently quotes the Lullian alchemical writings with approval as well as citing Geber and other authors. The work of Tauladanus was published in 1561 by Gratarolus in *Veræ alchemiæ*³⁸, but I have failed to find any trace of an earlier edition contemporary with his letter to Sterpinus.

Gaudentius Merula was born at Labezzaro near Novara and taught the classics at Milan³⁹. His *Memorabilia*, printed at his native town in 1546,

³⁷ Following the preface of Gratarolus, the text proper of the *Lignum vitæ* occupies pp. 3-46 of *Veræ alchemiæ*.

³⁸ *Veræ Alchemiæ*, Basel, 1561, pp. 46-111. The letter to Sterpinus occupies pp. 47-8.

³⁹ Argellati, *Bibliotheca scriptorum Mediolanensium*, Milan, 1745, however, does not mention him.

then at Venice in 1550, and at Lyons in 1556 in an enlarged edition, contain some alchemy as well as astrology, natural philosophy, history and theology. Marco Antonio Majoragio was the author of two orations, one in praise of gold, the other apologetic against Merula, but I do not know that either bore upon alchemy⁴⁰. In the *Musæum metallicum* of Aldrovandi, which was published long after his death in the middle of the seventeenth century, the *Memorabilia* of Gaudentius Merula are cited for such an astrological image as carving a scorpion on a bezoar stone while the moon is traversing the sign of Scorpio in order not to be stung by scorpions. Again he is cited for suspending the stone selenites from the neck with a silver thread while the moon is in Taurus or Cancer in order to produce lunar effects⁴¹. Gaudentius Merula was also cited by William Gilbert in 1600 as a previous writer on the magnet⁴².

A collection of alchemical opuscula, printed at Frankfurt in 1550, included the *Correctio fatuorum* again, a *Clangor buccinæ*, *Scala philosophorum*, *Opus mulierum et ludus puerorum*, *Rosarium philosophorum*, the *Semita semitæ* of Arnald of Villanova, and works ascribed to Aristotle, Avicenna and Raymond Lull⁴³. The Lullian tracts were the *Anima artis* and *Vade mecum*. The *Opus mulierum et ludus puerorum* is here said to derive from a manuscript of the time of the Emperor Charles IV. To the second part or volume containing the *Rosarium philosophorum* is prefixed a brief list of alchemical authorities said to come from the *Speculum Naturale* of Vincent of Beauvais. Some seem of more recent date: Garsias, Raymond (Lull), 'who flourished in our recent times,' William Bishop called Huck, Aegidius master of the Hospital, who extracted a book concerning 125 stones, and Jacob Aranicus the Jew, who 'taught me not a little in that art'. In the dedication of the first part to Otto Henry, Count Palatine of the Rhine and Duke of Bavaria, Cyriacus Iacobus speaks in high terms of a Theophrastus Transsilvanus who had not long since used alchemical remedies to cure gout, leprosy and epilepsy, and who would seem to be no other than Paracelsus.

Interest in writings on alchemy was shown by bibliographical lists or notes which appeared in books published around the middle of the century. Gratarolo in 1561⁴⁴ mentioned such as to be found on the last leaf of the eighteenth chapter of the second book of Jean Fernel's *De abditis causis*, which first appeared

⁴⁰ The earliest edition of which I have found a notice is that of 1616, which I presume to be posthumous, since Majoragio had printed Paraphrases on Aristotle's two books on generation and corruption at Basel in 1554.

⁴¹ Ulysses Aldrovandi, *Musæum metallicum*, Bologna, 1648, iv, 33 and 59, pp. 685, 808, citing the *Memorabilia*, iv, 21.

⁴² *De magnetis magneticisque corporibus*, London, 1600, p. 7.

⁴³ *De alchimia opuscula complura veterum philosophorum . . .*, Francofurti, ex officina Cyriaci Jacobi, 1550. In 2 parts or volumes. All the treatises except *Clangor buccinæ* are included in Thorndike and Kibre, *A Catalogue of Incipits of Mediæval Scientific Writings in Latin*, 1937.

⁴⁴ In the Prolegomena to *Veræ alchemiæ* . . .

in 1548, at the close of the edition of Geber by Ioannes Petreius at Berne in 1545, in Euonymus Philiatrus of Zurich (a pseudonym of Gesner) and in Johann Lang's fifty-third epistle⁴⁵, and in the *Nomenclator insignium scriptorum* of Robertus Constantinus, Paris, 1555, which last contained a list of alchemical authors and works, some of which were in Greek or in manuscript.

Falloppio, in a course of lectures on metals and minerals which he completed at Padua on July 20, 1557, mentioned a druggist of Treviso who had made gold from quicksilver in the presence of the college and senate of Venice. In consequence his fame had spread all over Italy, and the incident was cited as an experimental proof of the truth of transmutation. Falloppio, however, asserted that he had deceived the Venetian senators and had been punished for it afterwards, and that, far from being enriched by gold-making, he had half died of hunger and hardly been able to keep his pharmacy going⁴⁶. Probably the incident had occurred some years before.

⁴⁵ Both Euonymus Philiatrus, *Thesaurus de remediis secretis* and the *Letters* of Lang seem to have been first printed in 1554.

⁴⁶ *Excellentissimi Gabrielis Falloppii de metallis seu fossilibus tractatus*, Venetiis ex officina Ludovici Avantii, MDLXIX : fol. 119v, 'præterea testem habemus fide dignissimum et iam facta est experientia, nam in Tarvisina civitate est seplasiarius quidam qui dicitur vulgo il spetiale dal Saracino. Seplasiarius ille præsentē collegio et senatu Veneto ex argento vivo præparato fecit aurum, nam confecerat quoddam suum lixivium ex hydrargyro et inspersit ipsum supra metalla, et factum est aurum, unde seplasiarius ille est iam in tota Italia nominatus'; fol. 123v, 'O Tarvisinius ille pharmacopola fecit aurum presente senatu Veneto. Dico quod quemadmodum lusit senatores illos ita etiam punitus est et sua brachia id sciunt. Et profecto fecit tantum auri quod fame quasi moritur et in sua officina vix sunt vasa pharmacalia, und sciatis quod sunt prorsus nænię quod ars faciat aurum'.

Concerning a similar adventurer at Venice and in Bavaria towards the close of the century a very full account has been given by Ivo Striedinger, *Der Goldmacher Marco Bragadino*, *Archivkundliche Studie zur Kulturgeschichte des 16. Jahrhunderts*, Munich, 1928, 379 pp., in *Archivalische Zeitschrift* herausg. vom Bayerischen Hauptstaatsarchiv, ii Beiheft.

Τοῦ αὐτοῦ Στεφάνου ἐπιστολὴ πρὸς Θεόδωρον.

Περὶ τοῦ ἀγροῦ γινώρι ὡς πολλοὺς γεωργοὺς ἀχρήστους ἔχει, καὶ εἰ μὴ τούτους ἐκβάλλῃς ἔξω, οὐ δύνασαι πρόσοδον ἀπὸ τοῦ ἀγροῦ λαβεῖν. εἰσὶν δὲ οἱ περὶ Κλαυδιανὸν καὶ τοὺς ἄλλους ὁμοῦ πάντες ἀδελφοὶ ἔξ· εἰ μὴ δύο χρήσιμοι μόνον οὐκ εἰσιν. καὶ ἡ λευκάργενος πᾶσα ἄχριστος. τί γὰρ ἡ δράκοντα ἔχει ὁ ἀγρός, καὶ διὰ τοῦ φυτῆματος ἀναξηραίνει τὸν τόπον, ἔνθα καὶ ἄττονοι ὑπάρχουσιν. ἐγὼ δὲ αὐτὸν εἶδον καὶ τὰς ποικίλλας¹ τοῦ σώματος αὐτοῦ φολίδας. καὶ ἡ μὲν ἀρχὴ τῆς οὐρᾶς αὐτοῦ λευκὴ ὡς γάλα, ἡ δὲ κοιλία καὶ ὁ νῶτος κροκοειδής, καὶ ἡ κεφαλὴ μελάγχλωρος. δεῖ δέ σοι εἰς τρία διελεῖν τὸν ἀγρόν, τοὺς τέσσαρας ἀδελφούς ἔν μέρος καὶ τὸν μέγα λίθον εἰς ἓν μέρος, οὕτως γὰρ πειρῶνται οἱ παλαιοὶ τοῦ ἀγροῦ ποιεῖν ὡς εὖρον οὕτως ποιεῖ ὁ μαγιστριανὸς Θεόδωρος καὶ Ἰάκωβος ὁ καβιδάριος διδασκαλεῖ. ἀληθής ἐστιν αἰθάλη τις ὑγρὰ καὶ αἰθάλη ξηρά. καὶ ἡ μὲν ὑγρὰ αἰθάλη ἀνασπᾶται διὰ τῶν φανῶν, τῶν ἐχόντων τοὺς μασθοὺς. ἡ δὲ ξηρὰ αἰθάλη διὰ χύτρας καὶ πώματος χαλκοῦ, ὡς ἀπὸ κινναβάρεως αἰθάλη λευκὴ. ἐὰν οὖν τὴν ξηρὰν αἰθάλην ποτίσῃς διὰ τῆς ὑγρᾶς αἰθάλης, θεῖον ἔργον ἀποτελεῖς. γίνωσκε δὲ ὅτι πᾶσαι αἱ οὐσίαι καὶ τὰ μέταλλα καὶ αἰθάλαι εἰσὶν, μᾶλλον δὲ γίνονται. αὗται γὰρ ποτισθεῖσαι γίνονται αἰθάλαι ὑγραί. ἡ Σκυθικὴ κόμαρις, ἣτις συγκραθεῖσα² τῇ νέᾳ αἰθάλῃ πάντα ἀποτελεῖ. καὶ ἄλλο ἐστὶν ἡ μυθικὴ χημία, καὶ ἄλλο ἡ μυστικὴ καὶ κρυπτὴ. καὶ ἡ μὲν μυθικὴ πολυπληθὴς λόγων συχέεται, ἡ δὲ μυστικὴ λόγῳ δημιουργίας κόσμον³ μεθοδεύεται, ἵνα ὁ θεόφρων καὶ ὁ θεογενὴς ἄνθρωπος διὰ τῆς εὐθείας ἐργασίας καὶ θεολογιῶν καὶ μυστικῶν λόγων μάθῃ.

Τοῦ αὐτοῦ Στεφάνου περὶ τοῦ ἐνόλου⁴ κόσμου.

Πρᾶξις σὺν θεῷ γ'.

Πῶς διοργανοῦνται καὶ πῶς ἐν αὐτῷ τὰ θεῖα μόρια ἐκκαθαίρομενα ἀνίπτανται ἐπίπεδα ἐπιπεδέστερα ἀγομενα· ἡ γὰρ μέθοδος τῆς μυστικῆς χημίας εἰκόνες εἰσὶν (Ω) καὶ τι δεῖ, μεθοδεύεται. οὕτως καὶ τὰ σώματα μεταλλευόμενα καὶ μεταλλοιούμενα ὑπὸ τῆς ἐναντίας φύσεως, μεθόδῳ τινὶ γίνονται ἐπίπεδος καὶ αἰθερώδης. ὦ σπέμα⁵ σπειρόμενον εἰς γῆν τῆς ς καὶ

¹ M.—ποικίλλας.

² M.—συγκραθεῖσα.

³ M.—κόσμον.

⁴ M.—ἐνύλον.

⁵ M.—σπέρμα.

THE ALCHEMICAL WORKS OF STEPHANOS OF ALEXANDRIA.

TRANSLATION AND COMMENTARY by F. SHERWOOD TAYLOR, Ph.D., M.A., B.Sc.

PART II.

LETTER OF THE SAME STEPHANOS TO THEODOROS ⁷².

Concerning the field, know that it has many unprofitable farmers, and unless you cast these out, you will not be able to receive profit from the field. There are all the six brothers ⁷³ attendant on claudianos ⁷⁴ and the others together. Except the two useful ones, they are not one. And all the leucargenos ⁷⁵ is useless. For the field has a serpent ⁷⁶ and he dries up the place with his breath, where also men grow feeble. And I saw him and the spotted scales of his body. The beginning of his tail was white as milk, but his belly and back were saffron-coloured and his head was greenish-black. You should divide the field into three, the four brothers ⁷³ one part and the great stone one part, for thus the ancients attempted to do with the field, as I found out. For so does Theodoros the *agens in rebus* ⁷⁷, and so teaches Jakobos the lapidary ⁷⁸. True is a certain moist vapour ⁷⁹ and the dry vapour. For the moist is sublimed by the *phanoi* ⁸⁰ which have nipples. But the dry vapour <is distilled> by the pot and bronze cover, as is the white vapour from cinnabar ⁸¹. Therefore if you imbibe the dry vapour with the moist vapour, you perfect the divine work. For know that all the essences and the metals are also vapours, or rather become them, for the same, being imbibed, become moist vapours. The Scythian comaris ⁸², which is mixed with new vapour, perfects all things. And the legendary chemistry is one thing, and the mystical and hidden is another. For the legendary chemistry is confounded in a multitude of words, but the mystical is operated by the word of the Creator of the world, that the man who is holy and born of God may learn by the direct operation and by theological and mystical words.

THE SAME STEPHANOS, ON THE MATERIAL ⁸³ WORLD, LECTURE III WITH THE HELP OF GOD.

How the <world> is fashioned and how the divine parts of it, being well purified, fly upwards, which being level draw up after them the more level parts ⁸⁴. For the method of the mystical chemistry consists of symbols ~ ⁸⁵ and what is required is operated by method. So also the bodies, being made metallic and being changed from the contrary nature, become by a certain

ἀποτελεῖ ☉ καὶ διὰ τῆς θείας ἐργασίας ἡ τέφρα καὶ ἡ καδμεία καὶ ἡ σποδὸς τῶν λευκίνων ξύλων. καὶ τὰ θειώδη οὕτω τεφρωθέντα θεῖον πάλιν ἔργον καὶ ὕδωρ θεῖον ἄθικτον διὰ τῆς αὐτῶν τέφρας ποιοῦσιν εἰς παλιγγευσίαν. ἔστιν οὖν ἀντὶ πολλῶν κατανοήσαντα ὠρεῖν⁶, ὅτι ἡ τέφρα ἢ πολλὰ ποιοῦσα ἔργα μάλιστα τὰ βαφικὰ ἐὰν μὴ ὀλίγον ἢ τίτανος καὶ ἡ ἄσβεστος καὶ ἡ γύψος καὶ ἡ φέκλη καλουμένη, καὶ τὸ ἀφροσέληνον καὶ ὅσα τοιαῦτα εἶδη καίόμενα καὶ ἀποτεφρούμενα ποιοῦσι σποδὸν λευκὴν, ἔργα μεγάλα ἐπαγγέλλονται καὶ εἰς ἰατρείας καὶ εἰς χρωτῖσεις πάσας τὰς βαφικὰς μέχρι καὶ ὑέλων καὶ μαρμάρων· καὶ ἵνα μὴ δειλανθῇ ἀπὸ ἀπειρίας, καὶ γὰρ τοῦ Ἑρμοῦ λέγοντος, ἐὰν ἴδῃς τὰ πάντα σποδὸν γινόμενα, νόει ὅτι καλῶς ἐσκεύασται· ἡ γὰρ σποδὸς δυνάμεώς ἐστιν πλήρης καὶ ἐνεργείας. ὥσπερ γὰρ τὰ ξύλα τὰ ποιοῦντα στακτὴν ἄκαυστα γίνεται, τουτέστιν ἀποκεκαυμένα, καὶ ἀποτεφρούμενα, καὶ συμμιγέμενα τῷ χρυσοζωμίῳ μηκέτι καίόμενα, ἀλλὰ ἐνεργοῦντα εἰς πάσας τὰς βαφάς, μέχρι καὶ ἔργων καὶ μαρμάρων καὶ ὑέλων καὶ λίθων καὶ ξύλων καὶ δερμάτων καὶ πάντων ὁμοῦ τῶν χυτῶν σωμάτων, καὶ ἀπυτεφρωθέντα⁷ πολλὰ ἔργα καὶ θεῖα ποιοῦσιν. καὶ χρώματα διάφορα ὅσα ἀπὸ Δ κρόκου⁸ καὶ ὅσα ἀπὸ λιθαργύρου καὶ πάμμου⁹ τεφρούμενα καὶ ἐξαγαγόντα ἔξω τὴν φύσιν πάλιν εἰς τὸ φανερόν, τὰ μὲν ἐνεργά, τὰ δὲ δυνάμιν δι' ἐτέρας ὁμιλίας δεικνύοντα τὴν ἐνέργειαν. καὶ ὅσα μὲν οὖν ἔχει ὑμῖν ἀποδείξει ἀπὸ τῶν τεφρωμένων καὶ σποδωμένων, ἔσται ἱατρικῆς ἐπιστήμονος. ὅσα δὲ καὶ εἰς παλιγγευσίαν ἄρχονται¹⁰, εἰς εὐσύνητον τέχνην. μάλιστα οἱ τὴν σποδὸν τῶν ἀγοραίων βοτανῶν τῇ ἴσῃ συνεψούντες· καὶ τὰς σποδοὺς τῶν σωμάτων καὶ ὑέλων τῇ ἴσῃ συγχυνέοντες· ὥς οὐ δεῖ δειλιῶν ἐπὶ τῶν καιομένων καὶ τεφρουμένων τούτων τῶν σωμάτων. πάλιν γὰρ ἔχονται¹¹ εἰς τινα δυνάμιν καὶ ἐνέργειαν καὶ παλιγγευσίαν, φύσιν ἔχοντα μιμητικὴν τοῦ παντὸς κόσμου καὶ τῶν στοιχείων αὐτῶν ὅθεν καὶ τὴν παλιγγευσίαν ἔχοντα, πνεύματός τινος μετουσίαν, ὡς ὑλαίφῃ πνεύματι γινομένων. οὕτω καὶ ὁ χαλκὸς ὡς ἄνθρωπος καὶ ψυχὴν καὶ πνεῦμα ἔχει· ταῦτα γὰρ τὰ χυτὰ σώματα καὶ τὰ μεταλλικά. ὡς δ' ἂν ἀποτεφρωθῶσιν ὁμιλήσαντα τῷ πυρὶ, πάλιν πνευματοῦνται, πυρὸς αὐτοῖς χαριζομένου τὸ πνεῦμα. μεταλαμβάνοντα δηλονότι καὶ ἀπὸ τοῦ ἀέρος τοῦ τὰ πάντα ποιοῦντος, ὡς καὶ τοὺς ἀνθρώπους, καὶ τὰ πάντα ἐκεῖθεν δίδονται τὸ ζωτικὸν πνεῦμα καὶ ἡ ψυχὴ, οὕτως καὶ τὰ χυτὰ σώματα σὺν τῶν μεταλλικῶν ἀποτεφρωθέντα, μεθόδῳ τινὶ ἀνακομίζονται τὸ πνεῦμα, τῷ συγγενῇ πυρὶ ὥσπερ ἀναγινόμενα. πάντα δ' ὁμοῦ τὰ στοιχεῖα καὶ γενέσεις καὶ φθορὰς καὶ μεταβολὰς καὶ ἀνακάμψεις ἔχουσιν ἀπὸ ἐτέρου εἰς ἕτερον. οὕτως καὶ ὁ χαλκὸς καυθεὶς καὶ ἀνακαμφθεὶς ῥοδίνῃ ἐλαίῳ καὶ ἐκτιναχθεὶς, καὶ πολλὰκις τοῦτο παθὼν, χρυσοῦ κρείττων ἀσκίαστος γίνεται. τοῦτο δὲ τριπλοῦν χρὴ ἐκδέχεσθαι εἰς τε τὸ ἄβαφον καὶ τὸ βαπτόμενον, καὶ τὸ βάπττον. καὶ γὰρ διὰ βαφῆς ἀνακάμπτεται, καὶ τε θείως, καὶ τε ἱατρικῶς. καὶ ἐπὶ τῆς τοῦ

⁶ M.—εὑρεῖν.⁷ M.—ἀποτεφρωθέντα.⁸ M.—Sign of Saturn followed by κρόνου.⁹ M.—ψάμμου.¹⁰ M.—ἔρχονται.¹¹ M.—ἔρχονται.

method level and ætherial. O seed sown in the earth of silver, it also perfects gold, and by the divine work <so do> the ash⁸⁶ and cadmia and ash of white poplar wood⁸⁷. And the sulphurous things, being thus reduced to ash, make the work sulphurous again, and by their ash make the divine water untouched⁸⁸ for rebirth. The understanding person in opposition to the multitude may find that the ash—which does many works especially concerned with colouring if, to no small extent, chalk and lime and gypsum and what is called tartar, and aphroselenon and the other burnt and incinerated species make a white ash—promises wonderful things both for healing and for all the colorations by dyeing, both of glasses and marbles. And that you may not be made cowards by ignorance, hear what Hermes⁸⁹ says, ‘If you see the All becoming ash, know that it has been well prepared. For the ash is full of power and virtue.’ For just as woods which are made into lye become incombustible, that is to say burnt away and reduced to ashes, these being mixed with the liquor of gold⁹⁰ are no further burnt, but are operative for all sorts of tinctures, of marbles and glasses and stones and woods and skins and likewise of all fusible bodies. And being burnt to ashes they make many and divine works and various colours (as from lead⁹¹, and as from litharge and sand reduced to ashes), and leading the nature back outside to the visible. On the one hand they are active bodies, on the other hand a power, according to another discourse, displaying activity. And such things as he is able to display to you from matters incinerated and reduced to ashes pertain to the man skilled in medicine. For such things as come⁹² to rebirth, relate to an easily apprehended art, especially they who cook together the ash of common plants with the like, and melt together the ashes of bodies and glasses with the like. So that there is no need to be afraid of burning and reducing to ashes all these bodies. For they come⁹³ again to a certain power and virtue and re-birth, having a nature imitative of the whole universe and of the elements themselves, whence also they have re-birth, a communion with a certain spirit, as of things coming into existence by a material spirit. So copper, like a man, has both soul and spirit. For these melted and metallic bodies when they are reduced to ashes, being joined to the fire, are again made spirits, the fire giving freely to them its spirit. For as they manifestly take it from the air that makes all things, just as it also makes men and all things, thence is given them a vital spirit and a soul. So also the fusible bodies, being reduced to ashes with the metallic bodies, by a certain method recover their soul, as if becoming akin to the fire. And likewise all the elements have creations, destructions, changes and restorations from one to another. So also copper, being burnt and restored with oil of roses⁹⁴ and being expelled, after it has undergone this many times, becomes without stain, better than gold. But it is necessary to allow of this being threefold, for the un-tinged, the being-tinged and the tinged. For by the tincture it is restored, whether divinely or by way of healing. And on the question of that which is being tinged, understand this to be the restoration,

βαπτομένου δὲ τοῦτο νόει τὴν ἀνάκαμψιν, ὡς ὅταν ἀπὸ σποδοῦ καὶ τέφρας ἐπὶ ἐνέργειαν βαφικῇ¹² ἐρχόμενος τὴν ἐν δυνάμει καὶ τῆς δι' ἐνεργείας. εἰσὶ γάρ τινα τῶν πασχόντων ἀνακίμπτειν. τοῦτο δὲ εἶπεν ὅτι ζ' τῆς ἀληθοῦς συντέχνης καίεται καὶ πυρὶ φευκτόν ἐστιν, ἀλλὰ πάσχει ἀπὸ τοῦ πυρὸς καὶ αὐτὸ ἂν διαβὰς οὐ συγχέεται καὶ αἱ ὀπτήσεις τῶν κατ' Αἰγυπτίους ἐπιβολῶν οἷς κέχρηται καὶ οὐ συγχέεται τὸ φάρμακον τῇ βαφῇ. ὥσπερ γὰρ εἶπεν ὁ κριτικὸς διδύσκαιος καὶ φιλόσοφος καὶ καθηγητής, ὅτι ὥσπερ σφενδόνη παρερχομένη ἀκοῦσαι μὲν τινα, οἴχεται δὲ πετομένη τοῦ βύλλοντος ἰσχύει, οὕτως οὖν οἴχεται τοῦ ἀντιτιθέντος τὸ τραῦμα, ἀλλ' ὁ ἔχων ἔχει ὁ ποῖος, καὶ ἀληθῶς οἴχεται· οὕτω καὶ ἡ σποδὸς αὕτη ἔδραμεν καὶ βιάπτε ἀνεξαλείπτως καὶ ἀνεξάλειπτον ποιεῖ τῆς βαφῆς τὸ αἷτιον ἢ τὸ φάρμακον εἰς τὸ συγγενὲς πῦρ καὶ ἀέρα ἀναλύεται, ὡς ἐν κόλποις γονέων φεύγον καὶ ἀποκαίόμενον. εἴτα ἔχομεν ὑμῖν ἐτέρους μεγάλους λ' συγγράψιν¹³ πολλὰ καὶ πλείονα. οὗτος ὁ χαλκὸς ρ' ὁ πάντα πάσχων το πλεον παροπτούμενος γίνεται λίθος ἐτήσιος τῷ χρώματι ὡς τι σφύγγον ἐτήσιος. μετὰ οὖν τὸ ὀπτηθῆναι ἀποσβέννεται τῷ θεῖῳ ὑγρῷ, ὃ καλοῦσιν ὕδωρ θεῖον τὸ ἀπολυόμενον ἔλαιον, καὶ γίνεται οἶνος¹⁴ πάχος καὶ μείνας ἐκεῖ μάλιστα¹⁵ ἡμέραν θέρμην πραότητα ἀδιαπνεύστου ὀργάνου, ἢ ὕλη φθαρεῖσα λοιπὸν τὸ ἐμφανὲς μυστήριον τοῦ ὕδατος τοῦ θεῖου τὸ ἄθικτον τὸ ζητούμενον ἀποτελεῖ. καὶ αὐτὸ ἐστὶν ὁ λίθος, ὃ ταῦτα ποίων. ὥσπερ γὰρ ἡμεῖς τὰς τέσσαρας δυνάμεις, τουτέστι ἐσεκτικὴν¹⁶, δεκτικὴν, τονοτικὴν, ἀλλοιωτικὴν, τότε ποιοῦμεν τὸ ὕδωρ τοῦ θεῖου τὸ ἄθικτόν. τὸ πανβύβιον αἷμα ὡς δι' ὀργάνου διὰ τὸ τοῦ ἥπατος ὑποκείμενον τῇ γαστρὶ, καὶ τὸ σῶμα σχοῖν καὶ θάλπον αὐτῷ καὶ καῖον καὶ τὰ πάντα τὰ δύο θεῖα. τὸ γάλα ξανθὸν δὲ ἐν ἥπατι ἐξαιματοῦμεν πλεον ἀποζόντων¹⁷ τῶν φυτῶν. καὶ τοῦτο πάλιν τὸ εἰλικρινὲς ἔργον νεφροῖς¹⁸ ἐξαφρίζομεν ποιεῖ τὴν σποράν καὶ παλιγγενεσίαν. ὡς καὶ ἡ τέχνη μετὰ τὴν τῶν λευκῶν καὶ τῶν ξανθῶν ποιεῖ τὴν σύνθεσιν ἐπὶ ὀλίγων βολβήτων τουτέστι τὰς τῆς τέχνης ἐξαφρίσεις καὶ παλιγγενεσίας σπορά, ἵνα μετ' ὀλίγον χρόνον ἀποτεχνῇ¹⁹ ζητούμενον, σχήματι²⁰ καὶ χρώματι καὶ μεγέθει. καὶ ὧδε μὲν ἡ τέχνη ἔχει. ἐμεῖς²¹ δὲ διὰ τῶν στοιχείων. εἰ καὶ δι' αὐτῶν τὸ ζητούμενον τοῦ θηλείου καὶ τοῦ ἄρρενος ὁμοῦ ἐκθοροῦνται καὶ πλεοῦται τὸ γενόμενον. παρατῆρει οὖν καὶ ἐν τῇ τέχνῃ τὸ πῦρ καὶ τὸ ἐκθόρημα τοῦ πνεύματος οὐκ ἀναμένοντος. ἐνθα καὶ τὰ πταίσματα γίνονται προερεθισμοί, τὴν ψυχρότητα τὴν βήλειαν, τὴν δυσκίνητον, τὴν ἐκτρωμανῇ. ὧ δὲ καὶ καπνώδη καὶ ἄθικτον καὶ ἀνδροκαθίστρια μήτρα, παντὶ ἐπιθυμουμένη ὁπόταν τάχειον ποιήσῃ, ὃ ἐστὶ χαρὰς καὶ ἔρωτος ἀφροδισιακὸν σύμβολον ὃ ἐστὶν καχασμός. τοῦτο καὶ οἱ χρυσοχόοι εἰδότες ὃ λέγουσιν, τοῦτό φασιν ἐγάλασαν, καὶ τότε χρῶνται τῶν κατ' Αἰγυπτίους ἐπιβολῶν, ἅτινα ἐκφαυλιζόμενα αὐτὸς ὁ λίθος ὁ ἐτήσιος οἰκονομούμενος ποιεῖ ὅσα καὶ ἡμεῖς, καὶ μὴ θαυμάσης, εἰ ἐκ πολλῶν λίθων καὶ ἐτέρων

¹² M.—βαφικὴν.¹³ M.—συγγράψω.¹⁴ M.—οἶνου.¹⁵ M.—μᾶ.¹⁶ M.—ὀρεκτικὴν.¹⁷ M.—ἀπὸ ζόντων.¹⁸ M.—ἐν νεφροῖς.¹⁹ M.—ἀποτεχνῇ.²⁰ M.—σχηματεῖ.²¹ M.—ἐκεῖ.

as it is that which comes from the cinder and ash for the tinctural virtue which is in potency and through its actuality⁹⁵. For there are certain of the things that suffer restoration. For he says this, that the rainwater⁹⁶ (?) of the true art is burned and is fugitive in fire, but suffers from the fire and, crossing over, it is not melted. And <in> the roasting of the projections according to the Egyptian, which he uses, the drug is not melted in the tincture. So has said the critical teacher and philosopher and guide; just as a sling passing by someone may wound him⁹⁷ (that which is thrown is gone as a result of the strength of the thrower), so then is gone the wound of the man standing in the way. But he who has it, has it whoever he is, if indeed it truly is gone. So also the ash itself runs and tinges indelibly and makes indelible the cause of the tincture, or the drug is dissolved into its kindred fire and air, as being fugitive and burnt up in the bellies of its parents.

Then we have for you other great discourses⁹⁸ (?); I will write many things and more. This copper, suffering all things and being further roasted, becomes the etesian⁹⁹ stone in colour, etesian as something binding¹⁰⁰. After being roasted it is quenched in the divine moisture, which they call the divine water, the dissolved oil, and it becomes the thickness of wine, and there remaining for forty-one days¹⁰¹ in the gentle heat of a vapour-tight vessel, the matter being destroyed completes at length the apparent mystery, holy and sought-for, of the water of sulphur. And it is the stone which does these things. For just as we <make> the four powers, namely, the appetitive¹⁰², retentive, strengthening and alterative, then we make the virgin water of sulphur. The blood tinging all, as by an instrument, through the part of the liver lying beneath the stomach, both warming the body which has it and burning also the whole of the two sulphurs. For the yellow milk which is in the liver is changed into blood more than by the living plants. And again this pure work being despumated in the kidneys makes the seed and the re-birth. So also the art, according to the art of the white and the yellow, makes the synthesis from a little horse-dung, that is the despumation of the art, and the seed of re-birth, that after a little time you may construct¹⁰³ the thing sought for in form and colour and size. And thus is the work. For there <it is> by means of the elements, if also the thing sought by them is born of the female and the male likewise, and that which is generated is perfected.

For observe closely the fire in the art and the birth of the spirit which does not remain fixed. Then also mistakes become previous irritations¹⁰⁴, the female coldness, the slow to move, the miscarriage. Wherefore also the womb, lustful and virgin and the place of the man¹⁰⁵, all desirous whensoever it may be made quick¹⁰⁶, it is this which is the aphrodisiac symbol of joy and love, which is laughter¹⁰⁷. So also the melters of gold, understanding what they say, say this 'they laughed'¹⁰⁸, and then they employ projections according to the method of the Egyptian, which matters, being corrupted, the etesian stone itself operates when well managed, as also do we. And do not wonder if

εἰδῶν εἰς ὧν λίθος γίνεται καὶ λέγεται. ἥ οὐχ ὁρᾷς τοὺς τὴν μούσαν ἀπεργαζομένους καὶ τὰ καλὰ, ἵνα καὶ τὰ ζῷδια καὶ τοὺς θηλοὺς²², καὶ τὰς βαφάς, ὅτι ἐκ πολλῶν εἰδῶν ἓνα λίθον ποιοῦσι. μάλιστα οἱ διὰ **Δ** κρόνου καὶ χαλκόειδον γινόμενον, ὥστε καὶ γλυφῆς ἐπιδέεσθαι καὶ πάντα ὅσα ἂν οἱ λίθοι οἱ τοιοῦτοι οἱ χρήσιμοι, ἐκ πολλῶν λίθων ἓνα λίθον ποιοῦσιν, ὅντινα καλοῦσιν ἐτήσιον. διὰ τοῦτο τοῖς ἐτησίοις σκευάζεσθαι τὴν γραφὴν ὀπτοντες καὶ ἀποσβεννύοντες τὸ ἀπολελυμένον ὕδωρ, ὥσπερ ἔφιν, καὶ σήποντες ποιοῦσιν τὸ ὕδωρ τοῦτο τὸ θεῖον ἄθικτον τὸ ἀπὸ μόνου θείου. οὗτός ἐστιν ὁ λίθος ὁ ἐτήσιος. σὺν τούτοις ἔχει πᾶσιν ὀνόμασιν. οὗτος ὁ πορφυρῶς²³, ὁ ἐν τῷ πορφύρῳ μετάλλῳ εὐρίσκόμενος, ὁ διακασσιτήρου πορφυροχρῶμος μακεδονικός, καὶ εἴ τι ἄλλο λέγεται ἢ γράφεται ἢ σημαίνεται ἐν ταῖς θείαις καὶ ἀλληγορικαῖς γραφαῖς ὥστ' εἴ τι δ' ἂν σημαίνωσιν αἱ γραφαὶ περὶ πολλῶν ἀλληγοροῦσιν. οὗτός ἐστιν ὁ ἐτήσιος ὁ παρερμος²⁴ ὁ πολύχρῶμος, ὁ ἐν τῷ κλειδίῳ ἐκδοθεὶς πρὸς ἕκαστον χρῶμα οἰκονομούμενος, καὶ σὺν χαλκῷ ἀναδειχθεὶς καὶ ἐλαίῳ τοῦ φανοῦ ἀναλαμφθεὶς. οὗτος εὐτυχεὶς ἐποίησε τοὺς τῆς Ἀιγύπτου ἐπιμελητὰς καὶ τοὺς αὐτῶν προφήτας. καὶ ταῦτα μὲν περὶ τῶν ἀποτεφρωμένων καὶ σποδωμένων, καὶ ἀκανστούμενον ποιούντων ἔργων. περὶ δὲ τοῖς ἔργοις ἐλαιώσεως (μάλιστα γὰρ αὕτη εἴωθεν ποιεῖν τὰ πάντα) σποδὸν ποιοῦσιν διαφόρως μετὰ τὸ λευκανθῆναι τὸ λευκὸν σύνθεμα. καὶ πρῶτον μὲν ἡλίῳ καὶ δρόσῳ ἄλμη θαλάσσης, ἢ οὖρῳ ἢ ὀξύλμῃ ἡμέρας πολλὰς ἀναξηραίνοντες ἡλίου δυνάμει, καὶ ὀστράκων δαψιλέσι λειώσεσι. συνλειοῦσι τὴν ἰώσιν ὑδραργύρῳ, ἵνα καταποθῇ ἀπὸ τοῦ ξηρίου, καὶ ἐλαιώσαντες ἐψοῦσιν τῷ ἡλίῳ, ποτιοῦντες τῷ ὀργάνῳ ἐπὶ ἡμέρας²⁵ καὶ ἀναξηραίνοντες λειοῦσι πάλιν καὶ ὑγροῦσι. πάλιν ἀναξηραίνοντες λαμβάνουσιν ὀξύμελι καὶ ἐποπτοῦσιν ἐπὶ ἡμέρας τρεῖς. καὶ καρτεροῦσι ζῶντες καὶ φυλάσσουσι καὶ λειοῦσι πάλιν καὶ ποιοῦσιν οἶνου ἢ ἐλαίου πάχος, καὶ σήπουσι πραστάτῳ²⁶ πυρὶ ἐπὶ ἡμέρας μέγιστα²⁷ καὶ λειοῦσι²⁸ καὶ λαβόντες τὸ ἀργυροζῶμιον καὶ τὸ θεῖον μετὰ τῶν δαφνῶν καὶ τῶν ἄλλων πάντων ὀπτοῦσι καὶ ἐπιβάλλουσι χαλκὸν ἐξωθέντα, ὑέλῳ λαμπρῷ καὶ νίτρῳ καὶ μυσί.

²² M.—ὑελούς.

²³ M.—πορφυρίτης.

²⁴ M.—παρ ερμῇ.

²⁵ M.—ἡμερα.

²⁶ M.—πρασταγω.

²⁷ M.—μᾶ.

²⁸ M.—καὶ λειοῦσι καὶ λειοῦσι.

from many stones and various species the stone, being one, is born and is so spoken of. Do you not see that those who cultivate the muse and things of beauty, as they make animals and glasses and dyes, make a single stone from many species? Especially do they make it from lead ¹⁰⁹ and that which has become bronze-like, that they may not lack a carving. And as such useful stones make all such things, from many stones they make one stone, which they call the etesian stone. On account of this prepare the inscription ¹⁰⁹ for the etesian stones; concocting and quenching the water released, as I said, and putrefying it, they make the water which is divine, virgin, from a single sulphur. This is the etesian stone. With these it is called by all names. It is the porphyry ¹¹⁰ which is found in the purple mineral, the purple-coloured substance made from tin ¹¹¹, the Macedonian <stone>, and if any other name has been spoken of or written or symbolised in the divine and allegorical writing, it is that; for if the writings would signify any thing, they allegorise about many things. This the etesian stone, the many-coloured according to Hermes ¹¹², which is given out in the *Little Key* ¹¹³ as being operated for every colour and as being displayed with copper and revived by oil of the phanos ¹¹⁴. For he made fortunate those who had charge of Egypt and also their prophets. And these matters relate to the substances reduced to ashes and incinerated and to operations rendering the material incombustible. And concerning elæosis ¹¹⁵ for these works (for this especially is wont to perform all things) they make the ash in diverse fashion after the white composition has been whitened. And first of all with sun and dew ¹¹⁶, with brine ¹¹⁷ of sea-water, or with urine ¹¹⁸ or sour-brine ¹¹⁹, desiccating for many days by the power of the sun, and with ample triturations of potsherds, they triturate the iosis ¹²⁰ with mercury, that it may be absorbed by the dry powder; and submitting it to elæosis, they heat it in the sun imbibing it in the instrument for a day, and, drying it, they triturate it again and moisten it. Again drying it, they take oxymel ¹²¹ and heat it for three days, and while they live they are stedfast and watch and triturate again, and make it the thickness of wine or oil and putrefy it with a very gentle fire for 41 days ¹²², and triturate it [and triturate it] and taking the silver-liquid ¹²³ and sulphur after the laurels ¹²⁴ and all the other things, they heat them and project them on well-cleaned copper with shining glass ¹²⁵ and natron and misy ¹²⁶.

NOTES.

⁷² The name Theodoros occurs in the Greek alchemical writings : (1) in the *Dedication* (Berth., *Coll.*, iii, 4) where are mentioned 'the famous thoughts of Theodoros who is rich in god-inspired ways' ; (2) in the title of the work *Headings of the book of Zosimos addressed to Theodoros*.

The Theodoros mentioned in the *Dedication* is probably not identical with the Theodoros to whom Stephanos addresses the letter, for it is probable that the *Dedication* was written at the same time as the alchemical poems, which quote Stephanos and probably date from the eighth century.

⁷³ The six metals ; this is confirmed by a gloss of Pizimenti.

⁷⁴ Κλαυδιανός. This word is not a proper name. It is mentioned eleven times in the alchemical corpus. Berthelot conjectures that it may be a copper-lead alloy containing perhaps also zinc. He supposes the name to be equivalent to *aes Claudianum* (cf. *aes Marianum*, *Livianum* etc.). An examination of the texts renders this doubtful. It is classified with minerals (chrysocola, pyrites) rather than with metals.

⁷⁵ Λευκάργερος. Not in the lexicons, nor mentioned elsewhere in the alchemical corpus.

⁷⁶ The symbolism of the serpent or Dragon in Greek Alchemy is quite complex (v. Sherwood Taylor, *Ambix*, 1, 45-46). The specifying of the colour of the parts of the serpent is found also in two anonymous fragments of doubtful date (Berth., *Coll.*, iii, 21-3). The dragon seems here, as in later Alchemy, to be connected with the idea of putrefaction. A long passage in the late alchemical poem of Theophrastos on the Sacred Art develops the notion further (*Ideler*, ii, 332-3 : see also translation by C. A. Browne, *Scientific Monthly*, Sept. 1920, 204-5).

⁷⁷ Μαγιστριανός. An official position.

⁷⁸ Καβιδάριος. The word, which has elsewhere been translated as a proper name, Cabidarius, means 'lapidary' ; it does not seem to occur before the fifth century. Nothing is known of Theodoros or Jakobos.

⁷⁹ Αιθάλη. The vapours were regarded as spirits capable of penetrating and colouring metals.

⁸⁰ Φανός. This word in non-alchemical texts denotes a torch, lamp or lantern. Olympiodoros (Berth., *Coll.*, ii, 75) uses the word as equivalent to a cup . . . 'a cup or phanos of glass lying on the top' . . . But in the *Apparatus and Furnaces* of Zosimos (*ibid.*, ii, 234) we find : 'But it is possible to fix mercury in the phanos and similar apparatus with, as it were, a serpent-shaped base'. It is difficult to picture the apparatus.

⁸¹ Cf. Dioskurides, *Mat. Med.*, v, 110.

⁸² Κώμαρις. This word (also Κόμαρι, Κόμμαρι, Κόμαρις) is used in three senses, first and usually as a purple dye-stuff, secondly as a white earthy substance classified with Chian Earth, talc, selenite, etc. Lastly, in the Syriac texts it represents a highly poisonous substance, perhaps white arsenic (Berthelot, *La Chimie au Moyen Âge*, ii, 26).

⁸³ Ideler gives ἐνόλου, 'entire', but M. and many other MSS. give ἐιρόλου, 'material'. Piz. translates 'materiali'.

⁸⁴ Piz. : 'quæ plane planiores ducuntur'.

⁸⁵ Ideler prints this as Ω. It is, however, the sign for οὐρανός, heaven, and for the zodiacal sign Libra (ζυγός) ; v. *Catalogue des Manuscrits Alchimiques Grecs*, VIII, *Alchemistica Signa*, Zuretti, 1932, signs 1267, 1313, pp. 23-4.

⁸⁶ Τέφρα and σποδός seem both to be equivalent in the alchemical texts to 'ash' : σκωρία seems to be used chiefly of mineral products.

⁸⁷ Apparently taken from Hermes' lost work, quoted by Zosimos (Berth., *Coll.*, ii, 189).

⁸⁸ Ἀθικτος. A word much used in Greek Alchemy. In non-alchemical texts it signifies *untouched, virgin, not-to-be-touched, sacred*. In alchemical texts it is used chiefly of sulphur. The alchemical lexicon gives it the meaning τὸ καθαρὸν καὶ ἀμόλυντον, *the pure and undefiled (or undefiling)*: ὕδωρ θείου ἀθικτου, water of virgin sulphur, was used by early alchemical authors for tinting metals.

⁸⁹ This phrase is in character with Hermes' lost treatise but is not quoted elsewhere.

⁹⁰ See Note 47 (*Ambix*, 2, 137). Presumably alkali from wood ash was used in making polysulphide or thio-arsenate solutions for tinting metals.

⁹¹ Ideler has κρόκου (of saffron), but M. gives the sign of lead and also κρόνου (of Saturn).

⁹² Reading of M. adopted.

⁹³ The power of ashes to regenerate the plant from which they were made is met with again in the sixteenth and seventeenth centuries under the title *palingenesis* (cf. Stephanos, παλιγγενεσία). The underlying idea is, to quote an anonymous work on *Curiosities of Art and Nature in Husbandry and Gardening* (1707), that 'the Ideas, the Shadows, the Phantoms of Bodies preserve themselves in the salts that are extracted from them'. Some seventeenth-century authors regarded the salts extracted from these ashes as no less than the substantial form of the plants. The earliest author to mention palingenesis appears to be Paracelsus. It is discussed by some twenty other authors and most miraculous experiments adduced. Boyle (*Works*, ed. Birch, 1744, i, 216, b) tried experiments on the freezing of lixivia of ashes, and concluded that palingenesis was illusory. It would be interesting to know whether Stephanos was the source of the notion of palingenesis.

⁹⁴ Not mentioned in the works of earlier alchemists. Oil of natron is used by Mary for a similar purpose. Hippocrates makes frequent mention of oil of roses. This is presumably olive-oil scented with roses, not a distilled product. Stills for producing oil of roses, ῥοδοσπάγμα, are mentioned by late alchemical texts (*post* 1000 A.D.). Rose-water is mentioned under the latter name by the tenth-century authors Constantinus Porphyrogenetes and Theophanes Nonnus.

⁹⁵ Ἐνέργεια seems to be used both for 'virtue' or 'activity'—its usual alchemical sense—and also as a term of Aristotelean philosophy meaning 'existence in actuality' as opposed to δύναμις, existence in potency'.

⁹⁶ ρ. This sign does not correspond exactly to any recorded, but may be that for rain-water, ὕδωρ βροῦ (Zuretti, *op. cit.*, p. 18, sign 959), Piz. translates 'tutia'. The word is evidently neuter, so is unlikely to be the latter.

⁹⁷ Piz.: 'præter labens aliquem vulneraret', ἀκούσαι perhaps being taken for a part of ἀκοιτίζω.

⁹⁸ Piz. translates the sign as 'sermones'. . . . 'deinceps alios vobis sermones comparavi, in quibus multo plura conscribam'. The word omitted may be λόγους.

⁹⁹ Λίθος ἑτησίος seems to have been equivalent to some pyritic substance. It seems that cuprous oxide (*aes ustum*) may be intended above, which is of a similar colour to the reddish-purple iron oxide from burnt pyrites.

¹⁰⁰ Piz.: 'ut quidam coruscans æthesius'.

¹⁰¹ Ideler has μάλιστα; M. has μᾶ, 41. Piz. has 'per quadraginta dies' (see also note 133).

¹⁰² Following M.

¹⁰³ Ἀποτεχνῆ in Id.; Ἀποτεχνῆ in M. The word is not in the lexicons consulted.

¹⁰⁴ Προερεθισμός. The word is used by Galen (ed. Kuhn, Leipzig, xv, 622) in the sense of some condition, antecedent to a disease, which might weaken the bodily powers.

¹⁰⁸ Ἀνδροκαθίστρια. The word is not given in the lexicons. Ducange's *Glossarium Græcitatibus* cites only this source. Piz. translates 'in quo masculus cubat'. The word might mean 'seat of the male' from ἀνὴρ and καθιστήριον or some such word.

¹⁰⁹ Τάχειον. The meaning is doubtful. The word does not seem to bear the meaning 'quick' = pregnant.

¹⁰⁷ Piz. refers in a gloss to 'Lullus in codicillo 149 in cap. Quid sit materia lapidis.' The passage intended appears to be that given in Chapter L of the *Codicillum* as printed by Manget, *Bibliotheca Chymica Curiosa*, i, 897.

¹⁰⁸ This curious passage seems designed to explain a phrase in the short recipe entitled the *Diplosis of Eugenios* (Berth., *Coll.*, ii, 39, 9). The recipe specifies 'Burnt copper three parts. Gold one part. Melt and throw in arsenic. Calcine and you will find it brittle. Then triturate with vinegar for six days in the sun. Then after drying it, melt silver καὶ γελάσαν. . . .', which last phrase may be translated 'and it laughed'. This phrase is presumably an ancient copyist's error, to explain which Stephanos has used his ingenuity.

¹⁰⁹ Γραφήν, so also M. Piz. evidently reads βαφήν, for he translates 'tincturam'.

¹¹⁰ Not mentioned elsewhere in alchemical texts.

¹¹¹ It is hard to resist the suggestion that this is the earliest reference to purple of Cassius.

¹¹² Id. has παρερμος, which does not appear in the dictionaries. M. has παρ ερμῆ. Piz. translates 'apud Hermetem', which the next line confirms.

¹¹³ The *Kleidion* or *Little Key* of Hermes is lost. It is mentioned in the compilation of Christianus Philosophus (Berth., *Coll.*, ii, 281, 18-19) and evidently dealt with these purple stones which are in one place identified with ἰόχαλκος, and therefore may be cuprous oxide.

¹¹⁴ Piz. translates 'raphani'. Oil of radish, ἔλαιον ῥαφάνιον, is often mentioned in the texts.

¹¹⁵ Ἐλαιώσεως. Only found in alchemical texts. Zosimos in his *Chapter-headings of the Work addressed to Theodore* (Berth., *Coll.*, ii, p. 215, 1) says: 'Concerning the etesian stone. . . . For by means of the treatment it shows another colour, one from the kerotakis and one from the elæosis'. So little is known of the process that the transliteration *elæosis* is perhaps better than the translation *cevatio* given by Piz.

¹¹⁶ Exposure to dew and sun was practised in the recipes of the Papyrus Holmiensis and in recipes of Demokritos (Berth., *Coll.*, ii, 45, 22, v; also 155, 6, 10) and Zosimos (*ibid.*, 113, 18).

¹¹⁷ Ἀλμη. Brine is used only in the Demokritan recipes or in passages deriving therefrom. Its use is for treating various mineral substances (Berth., *Coll.*, ii, 45, 2; 45, 14; 45, 21; 20, 17; 51, 12; 52, 9; 54, 17, etc.).

¹¹⁸ Οὔρον. Urine is used extensively in recipes of the chemical papyri and in recipes of the Demokritan type. Its use is as a corrosive and detergent liquid similar to brine (Berth., *Coll.*, ii, pp. 44-55, 288-312 *passim*).

¹¹⁹ Ὁξάλμη. A mixture of brine and vinegar. Mentioned as *materia medica* by Dioskurides (*Mat. Med.*, v, 33) and much used as a corrosive material in the Demokritan recipes (Berth., *Coll.*, ii, 44, 15; 45.12-14; 288, 24; 394, 4; 395, 24; 308, 28, etc.). It is mentioned in the Papyrus of Leyden (Recipe 48).

¹²⁰ Perhaps here used for a mixture designed to bring about coloration (Sherwood Taylor, *Ambix*, 2, p. 138, note ⁵³).

¹²¹ Ὁξυμέλι was a mixture of vinegar and honey often used as a medicament (Dioskurides, *Mat. Med.*, v, 22). Demokritos employs it as a corrosive in the treatment of pyrites (Berth., *Coll.*, ii, 44, 16).

¹²² Ideler has *μεγιστα* M. has *μα̃*, 41. Piz. translates 'per quadraginta dies' (see note ¹¹⁰).

¹²³ *Ἀργυροζώμιον* is mentioned in two passages (Berth., *Coll.*, ii, 19, 14; 214, 5). The first speaks of the '*argyrozomion* which is of citrons'; the second is very obscure but seems to indicate the meaning given here.

¹²⁴ *Δαφνῶν*, Laurels. Possibly a cover-name for arsenic trioxide, mercury or 'white sulphur'. The only phrase which can explain this curious symbolism, which finds parallels in several early texts, is an '*Oracle of Apollo*' (Berth., *Coll.*, ii, 276, 4-5), where, apropos of the distillation or sublimation of mercury, it is said, that 'Like a virgin laurel it raises itself on to the lids of cauldrons'.

¹²⁵ The use of glass in a projection is not found elsewhere in alchemical texts.

¹²⁶ *Μίσν*. Misy is mentioned by Dioskurides and by Pliny (*Hist. Nat.*, xxxiv, 31). It is evidently a mixture of basic iron and copper sulphates resulting from the natural oxidation of pyrites. It is used in a great number of recipes of the Demokritan type and also in the recipes of the Chemical Papyri. It was apparently used:

- (a) for the surface removal of copper from base gold (*Papyrus of Leyden*, 15, 17, 25, 51, 69, 76, 88);
- (b) in the arsenical mixtures used for whitening copper (Berth., *Coll.*, ii, 46, 20; 53, 2; 138, 2; 223, 14; 286, 8; 288, 12);
- (c) in the surface cleaning or coloration of metals (*ibid.*, 46, 2; 166, 17);
- (d) in yellow varnishes destined for the surface coloration of metals (*ibid.*, 56, 2; 310, 25);
- (e) in the so-called 'yellow sulphur' (*ibid.*, 45, 2; 166, 17);
- (f) as a mordant in dyeing (*Papyrus Holmiensis*, ιζ, 1; κδ, 12, 35; η, 12).

REVIEWS.

Hudud al-'Ālam (The Regions of the World). Translated and explained by V. MINORSKY. With the Preface by V. V. BARTHOLD. Pp. xx+524. E. J. W. Gibb Memorial, New Series, XI. London, 1937. 25s.

THIS most important geographical work is anonymous and was compiled in 982/3 A.D. It is written in Persian and dedicated to a local ruler of what is now northern Afghanistan, and the manuscript, which is unique, was made known to western scholars by the late Russian orientalist A. G. Toumansky. The manuscript was edited in Russia, in 1930, by the Academy of Sciences of the U.S.S.R., and in Persia as an annex to a calendar in 1935 (!).

The work describes the regions of the world known to the educated classes of the day, and much of its importance lies in the fact that it contains more detailed descriptions of non-Muslim countries than are usually found in the works of the geographers of Islam. The value of this book for the student is greatly enhanced by Dr. Minorsky's excellent commentary, which is contained in Part III, and without which the text would be more or less meaningless to the non-orientalist. Part III also has 12 maps.

For the historian of science and scientific origins Index D is of especial interest. Here are many references to drugs, metals, minerals, precious stones, sugar, and to other relevant subjects. In every case there are copious references to the source material.

[G. H.]

Das Buch der Alaune und Salze. Ein Grundwerk der spätlateinischen Alchemie. By JULIUS RUSKA. Pp. 127. Berlin: Verlag Chemie, 1935. RM. 11.25.

THE treatise *De Aluminibus et Salibus* is one of the most important documents of mediæval alchemy. It was used by Roger Bacon and Vincent of Beauvais as a source, and it undoubtedly exercised a great influence on the development of later European alchemy. It deals principally with the materials used in alchemy, such as the alums and salts, stones, marcasites, sulphurs, glasses and mercury, and has a pronounced practical trend, the spirit of observation and experiment being well developed, whilst the mystical tendencies of alchemy are kept in the background. Prof. Ruska shows that the work, which was attributed to Rāzī, was probably compiled in Muslim Spain in the 11th century. He considers that the Muslim chemists were in possession of many more Greek authors and works on alchemy than are known to us in the original, but that a new direction was given to Muslim alchemy by such men as Rāzī (accounts of whose work in alchemy were recently published in *Ambix*, 1938, 1, 184, 192), in which the experimental aspect was developed as more significant than the mystical. The present work, although not by Rāzī himself, follows this tradition. It is of the greatest interest and significance in the history of alchemy and chemistry, and has been admirably edited by Prof. Ruska. He gives the Latin text and a translation and also some Arabic fragments and their translation. The introduction deals fully with the transmission of the work and its influence on mediæval writers, and the translation of the text is accompanied by useful notes and explanations. It is very unfortunate that there is no index, and the table of contents is also very brief. Prof. Ruska has put

all who are interested in the history of alchemy in touch with a most important document, and the book is one of outstanding importance and value. The printing and paper are of excellent quality. The book is cordially recommended to readers of *Ambix*. [J. R. P.]

Sinn und Aufgabe der Geschichte der Chemie. By E. PIETSCH. Pp. 32. Berlin: Verlag Chemie, 1937. RM. 0.90.

THIS small pamphlet, by the Editor-in-Chief of *Gmelins Handbuch der anorganischen Chemie*, contains a very thoughtful discussion of several aspects of the study of the history of chemistry and alchemy which should be of exceptional interest to readers of *Ambix*. It is based on the proposition that the history of chemistry is a part, and an important part, of the general history of the development of culture and of ideas which can throw light on the history of the development of the human spirit. Chemistry played an important part in moulding the progress of thought in many epochs, and the author gives a clear, objective and surprisingly complete and satisfying survey of the whole history of the development of this science. He next develops the thesis that a knowledge of the history of chemistry can serve a most important purpose in directing future developments of great significance, and in so doing can lead to economy of effort, at the same time providing suggestions for possible lines of theoretical and, above all, of practical development. This thesis is supported by concrete evidence and must be regarded as abundantly proved. A most important matter dealt with is the effect of intensive specialized work on the mental and spiritual outlook of the scientific worker, and it is shown that this can lead to most undesirable consequences both for the individual and for the community unless it is accompanied by some type of mental occupation which can provide a more general background than that furnished by narrow specialization. Dr. Pietsch's essay is one which provides abundance of material of the greatest interest to the specialist in historical studies, and it also gives a philosophical and stimulating survey of an aspect of human culture which deserves close study by all who have the future of civilization in mind. The work is cordially recommended to readers of *Ambix*. [J. R. P.]

